Department of Defense
Fiscal Year (FY) 2019 Budget Estimates

February 2018

Office of the Secretary Of Defense

Defense-Wide Justification Book Volume 3A of 5

Research, Development, Test & Evaluation, Defense-Wide

Budget Activities 1−3

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OSD RDT&E Overview

The OSD RDT&E budget provides ongoing support and oversight of research, development, and testing for the Office of the Secretary of Defense (OSD) Principal Staff Assistants, Military Services and other DoD agencies while eliminating duplication of efforts. It represents requirements from the Services that has been coordinated with appropriate Office of the Secretary of Defense (OSD) organizations.

The OSD RDT&E budget is divided into seven budget activities (BA 1-7) ranging from basic research to full scale operational system development consisting of programs such as research grants, STEM education, laboratory research, innovation & technology, manufacturing institutes, combatting terrorism, wargaming, physical security, cyber security, systems engineer, small business interests among many more.

The OSD RDT&E Program is committed to and has achieved numerous milestones and individual accomplishments which are presented in the FY 2019 President's Budget justification book.

FY 2019 OSD RDT&E President's Budget request is approximately $4.6 billion.

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

01 Feb 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, DW	4,084,372	4,041,233	4,041,233	25,000	25,000
Total Research, Development, Test & Evaluation	4,084,372	4,041,233	4,041,233	25,000	25,000

Department of Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
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01 Feb 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, DW	368,100	-368,100		4,434,333	-368,100	4,066,233
Total Research, Development, Test & Evaluation	368,100	-368,100		4,434,333	-368,100	4,066,233

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

01 Feb 2018

Appropriation	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research, Development, Test & Eval, DW	4,650,932	25,000	4,675,932
Total Research, Development, Test & Evaluation	4,650,932	25,000	4,675,932

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

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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	176,454	140,775	140,775		
Applied Research	134,909	141,815	141,815		
Advanced Technology Development	1,172,233	1,128,893	1,128,893	25,000	25,000
Advanced Component Development And Prototypes	1,556,862	1,685,375	1,685,375		
System Development And Demonstration	284,189	341,821	341,821		
Management Support	690,532	534,872	534,872		
Operational System Development	69,193	67,682	67,682		
Total Research, Development, Test & Evaluation	4,084,372	4,041,233	4,041,233	25,000	25,000

Summary Recap of FYDP Programs	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
General Purpose Forces	2,070	2,551	2,551		
Intelligence and Communications	85,848	118,990	118,990		
Research and Development	3,966,868	3,919,692	3,919,692	25,000	25,000
Training Medical and Other	29,149				
Administration and Associated Activities	437				
Total Research, Development, Test & Evaluation	4,084,372	4,041,233	4,041,233	25,000	25,000

R-119PB: FY 2019 President's Budget (Published Version), as of February 1, 2018 at 13:17:56

Department of Defense
FY 2019 President's Budget
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Basic Research				140,775		140,775
Applied Research				141,815		141,815
Advanced Technology Development	5,000	-5,000		1,158,893	-5,000	1,153,893
Advanced Component Development And Prototypes	333,100	-333,100		2,018,475	-333,100	1,685,375
System Development And Demonstration				341,821		341,821
Management Support	30,000	-30,000		564,872	-30,000	534,872
Operational System Development				67,682		67,682
Total Research, Development, Test & Evaluation	368,100	-368,100		4,434,333	-368,100	4,066,233

Summary Recap of FYDP Programs						
General Purpose Forces				2,551		2,551
Intelligence and Communications				118,990		118,990
Research and Development	368,100	-368,100		4,312,792	-368,100	3,944,692
Training Medical and Other						
Administration and Associated Activities						
Total Research, Development, Test & Evaluation	368,100	-368,100		4,434,333	-368,100	4,066,233

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Summary Recap of Budget Activities	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Basic Research	159,033		159,033
Applied Research	155,723		155,723
Advanced Technology Development	1,236,619	25,000	1,261,619
Advanced Component Development And Prototypes	2,019,673		2,019,673
System Development And Demonstration	386,469		386,469
Management Support	637,055		637,055
Operational System Development	56,360		56,360
Total Research, Development, Test & Evaluation	4,650,932	25,000	4,675,932

Summary Recap of FYDP Programs	FY 2019 Base	FY 2019 OCO	FY 2019 Total
General Purpose Forces	3,008		3,008
Intelligence and Communications	201,078		201,078
Research and Development	4,446,846	25,000	4,471,846
Training Medical and Other			
Administration and Associated Activities			
Total Research, Development, Test & Evaluation	4,650,932	25,000	4,675,932

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Advanced Technology Development	1,172,233	1,128,893	1,128,893	25,000	25,000
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Appropriation: 0400D Research, Development, Test & Eval, DW

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	S e c
3	0601110D8Z	Basic Research Initiatives	01	66,750	40,612	40,612			U
5	0601120D8Z	National Defense Education Program	01	76,995	74,298	74,298			U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01	32,709	25,865	25,865			U
		Basic Research		176,454	140,775	140,775			
8	0602000D8Z	Joint Munitions Technology	02	17,611	19,111	19,111			U
10	0602230D8Z	Defense Technology Innovation	02	9,989					U
11	0602234D8Z	Lincoln Laboratory Research Program	02	46,500	49,748	49,748			U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02	40,798	49,226	49,226			U
16	0602668D8Z	Cyber Security Research	02	11,906	14,775	14,775			U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02	8,105	8,955	8,955			U
		Applied Research		134,909	141,815	141,815			
23	0603000D8Z	Joint Munitions Advanced Technology	03	23,742	25,627	25,627			U
24	0603122D8Z	Combating Terrorism Technology Support	03	113,366	76,230	76,230	25,000	25,000	U
25	0603133D8Z	Foreign Comparative Testing	03	18,966	24,199	24,199			U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03	16,618	18,662	18,662			U
36	0603288D8Z	Analytic Assessments	03	11,603	13,154	13,154			U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03	55,679	37,674	37,674			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
3	0601110D8Z	Basic Research Initiatives	01				40,612		40,612	U
5	0601120D8Z	National Defense Education Program	01				74,298		74,298	U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01				25,865		25,865	U
		Basic Research					140,775		140,775	
8	0602000D8Z	Joint Munitions Technology	02				19,111		19,111	U
10	0602230D8Z	Defense Technology Innovation	02							U
11	0602234D8Z	Lincoln Laboratory Research Program	02				49,748		49,748	U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02				49,226		49,226	U
16	0602668D8Z	Cyber Security Research	02				14,775		14,775	U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02				8,955		8,955	U
		Applied Research					141,815		141,815	
23	0603000D8Z	Joint Munitions Advanced Technology	03				25,627		25,627	U
24	0603122D8Z	Combating Terrorism Technology Support	03				101,230		101,230	U
25	0603133D8Z	Foreign Comparative Testing	03				24,199		24,199	U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03				18,662		18,662	U
36	0603288D8Z	Analytic Assessments	03				13,154		13,154	U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03				37,674		37,674	U

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Appropriation: 0400D Research, Development, Test & Eval, DW

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
3	0601110D8Z	Basic Research Initiatives	01	42,702		42,702	U
5	0601120D8Z	National Defense Education Program	01	85,919		85,919	U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01	30,412		30,412	U
		Basic Research		159,033		159,033	
8	0602000D8Z	Joint Munitions Technology	02	19,170		19,170	U
10	0602230D8Z	Defense Technology Innovation	02				U
11	0602234D8Z	Lincoln Laboratory Research Program	02	51,596		51,596	U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02	60,688		60,688	U
16	0602668D8Z	Cyber Security Research	02	14,969		14,969	U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02	9,300		9,300	U
		Applied Research		155,723		155,723	
23	0603000D8Z	Joint Munitions Advanced Technology	03	25,598		25,598	U
24	0603122D8Z	Combating Terrorism Technology Support	03	125,271	25,000	150,271	U
25	0603133D8Z	Foreign Comparative Testing	03	24,532		24,532	U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03	18,644		18,644	U
36	0603288D8Z	Analytic Assessments	03	19,472		19,472	U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03	37,263		37,263	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	S e c
38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03		15,000	15,000			U
41	0603375D8Z	Technology Innovation	03	24,895	59,863	59,863			U
43	0603527D8Z	RETRACT LARCH	03	175,135	171,120	171,120			U
44	0603618D8Z	Joint Electronic Advanced Technology	03	21,376	14,389	14,389			U
45	0603648D8Z	Joint Capability Technology Demonstrations	03	127,961	105,871	105,871			U
46	0603662D8Z	Networked Communications Capabilities	03	9,123	12,661	12,661			U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03	177,419	136,159	136,159			U
49	0603699D8Z	Emerging Capabilities Technology Development	03	54,279	57,876	57,876			U
52	0603716D8Z	Strategic Environmental Research Program	03	63,177	71,832	71,832			U
54	0603727D8Z	Joint Warfighting Program	03	4,581	6,349	6,349			U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03	10,384	11,211	11,211			U
60	0603781D8Z	Software Engineering Institute	03	13,726	15,047	15,047			U
61	0603826D8Z	Quick Reaction Special Projects	03	77,354	69,203	69,203			U
62	0603833D8Z	Engineering Science & Technology	03	22,198	25,395	25,395			U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03						U

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38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03				15,000		15,000	U
41	0603375D8Z	Technology Innovation	03	5,000	-5,000		64,863	-5,000	59,863	U
43	0603527D8Z	RETRACT LARCH	03				171,120		171,120	U
44	0603618D8Z	Joint Electronic Advanced Technology	03				14,389		14,389	U
45	0603648D8Z	Joint Capability Technology Demonstrations	03				105,871		105,871	U
46	0603662D8Z	Networked Communications Capabilities	03				12,661		12,661	U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03				136,159		136,159	U
49	0603699D8Z	Emerging Capabilities Technology Development	03				57,876		57,876	U
52	0603716D8Z	Strategic Environmental Research Program	03				71,832		71,832	U
54	0603727D8Z	Joint Warfighting Program	03				6,349		6,349	U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03				11,211		11,211	U
60	0603781D8Z	Software Engineering Institute	03				15,047		15,047	U
61	0603826D8Z	Quick Reaction Special Projects	03				69,203		69,203	U
62	0603833D8Z	Engineering Science & Technology	03				25,395		25,395	U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03							U

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38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03	13,621		13,621	U
41	0603375D8Z	Technology Innovation	03	83,143		83,143	U
43	0603527D8Z	RETRACT LARCH	03	161,128		161,128	U
44	0603618D8Z	Joint Electronic Advanced Technology	03	12,918		12,918	U
45	0603648D8Z	Joint Capability Technology Demonstrations	03	106,049		106,049	U
46	0603662D8Z	Networked Communications Capabilities	03	12,696		12,696	U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03	114,637		114,637	U
49	0603699D8Z	Emerging Capabilities Technology Development	03	48,338		48,338	U
52	0603716D8Z	Strategic Environmental Research Program	03	76,514		76,514	U
54	0603727D8Z	Joint Warfighting Program	03	5,992		5,992	U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03	13,564		13,564	U
60	0603781D8Z	Software Engineering Institute	03	15,050		15,050	U
61	0603826D8Z	Quick Reaction Special Projects	03	69,626		69,626	U
62	0603833D8Z	Engineering Science & Technology	03	19,415		19,415	U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03	69,533		69,533	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
64	0603941D8Z	Test & Evaluation Science & Technology	03	89,605	89,586	89,586			U
65	0604055D8Z	Operational Energy Capability Improvement	03	41,459	38,403	38,403			U
66	0303310D8Z	CWMD Systems	03	19,587	33,382	33,382			U
		Advanced Technology Development		1,172,233	1,128,893	1,128,893	25,000	25,000	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04	25,851	32,937	32,937			U
69	0603600D8Z	WALKOFF	04	96,038	101,714	101,714			U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04	1,761	2,198	2,198			U
71	0603851D8Z	Environmental Security Technical Certification Program	04	46,440	54,583	54,583			U
89	0603920D8Z	Humanitarian Demining	04	9,740	10,837	10,837			U
90	0603923D8Z	Coalition Warfare	04	9,789	10,740	10,740			U
91	0604016D8Z	Department of Defense Corrosion Program	04	14,394	3,837	3,837			U
93	0604132D8Z	Missile Defeat Project	04	138,350	98,369	98,369			U
96	0604250D8Z	Advanced Innovative Technologies	04	850,762	1,175,832	1,175,832			U
97	0604294D8Z	Trusted & Assured Microelectronics	04		83,626	83,626			U
98	0604331D8Z	Rapid Prototyping Program	04	100,000	100,000	100,000			U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04	7,254	3,967	3,967			U

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64	0603941D8Z	Test & Evaluation Science & Technology	03				89,586		89,586	U
65	0604055D8Z	Operational Energy Capability Improvement	03				38,403		38,403	U
66	0303310D8Z	CWMD Systems	03				33,382		33,382	U
		Advanced Technology Development		5,000	-5,000		1,158,893	-5,000	1,153,893	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04				32,937		32,937	U
69	0603600D8Z	WALKOFF	04				101,714		101,714	U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04				2,198		2,198	U
71	0603851D8Z	Environmental Security Technical Certification Program	04				54,583		54,583	U
89	0603920D8Z	Humanitarian Demining	04				10,837		10,837	U
90	0603923D8Z	Coalition Warfare	04				10,740		10,740	U
91	0604016D8Z	Department of Defense Corrosion Program	04				3,837		3,837	U
93	0604132D8Z	Missile Defeat Project	04	26,400	-26,400		124,769	-26,400	98,369	U
96	0604250D8Z	Advanced Innovative Technologies	04	306,700	-306,700		1,482,532	-306,700	1,175,832	U
97	0604294D8Z	Trusted & Assured Microelectronics	04				83,626		83,626	U
98	0604331D8Z	Rapid Prototyping Program	04				100,000		100,000	U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04				3,967		3,967	U

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64	0603941D8Z	Test & Evaluation Science & Technology	03	96,389		96,389	U
65	0604055D8Z	Operational Energy Capability Improvement	03	40,582		40,582	U
66	0303310D8Z	CWMD Systems	03	26,644		26,644	U
		Advanced Technology Development		1,236,619	25,000	1,261,619	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04	28,140		28,140	U
69	0603600D8Z	WALKOFF	04	92,222		92,222	U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04	2,506		2,506	U
71	0603851D8Z	Environmental Security Technical Certification Program	04	40,016		40,016	U
89	0603920D8Z	Humanitarian Demining	04	11,347		11,347	U
90	0603923D8Z	Coalition Warfare	04	8,528		8,528	U
91	0604016D8Z	Department of Defense Corrosion Program	04	3,477		3,477	U
93	0604132D8Z	Missile Defeat Project	04	58,607		58,607	U
96	0604250D8Z	Advanced Innovative Technologies	04	1,431,702		1,431,702	U
97	0604294D8Z	Trusted & Assured Microelectronics	04	233,142		233,142	U
98	0604331D8Z	Rapid Prototyping Program	04	99,333		99,333	U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04	3,781		3,781	U

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101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04	3,850	3,833	3,833			U
102	0604775D8Z	Defense Rapid Innovation Program	04	250,000					U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04	2,633	2,902	2,902			U
		Advanced Component Development And Prototypes		1,556,862	1,685,375	1,685,375			
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05	10,152	12,536	12,536			U
119	0604165D8Z	Prompt Global Strike Capability Development	05	161,100	201,749	201,749			U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05	15,691	15,358	15,358			U
125	0605022D8Z	Defense Exportability Program	05	2,853	3,162	3,162			U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05	16,131	21,353	21,353			U
128	0605075D8Z	DCMO Policy and Integration	05		2,810	2,810			U
131	0605140D8Z	Trusted Foundry	05	67,252					U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05	8,310	11,870	11,870			U
133	0605294D8Z	Trusted & Assured Microelectronics	05		61,084	61,084			U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05	2,700	3,669	3,669			U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05		8,230	8,230			U
		System Development And Demonstration		284,189	341,821	341,821			

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101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04				3,833		3,833	U
102	0604775D8Z	Defense Rapid Innovation Program	04							U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04				2,902		2,902	U
		Advanced Component Development And Prototypes		333,100	-333,100		2,018,475	-333,100	1,685,375	
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05				12,536		12,536	U
119	0604165D8Z	Prompt Global Strike Capability Development	05				201,749		201,749	U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05				15,358		15,358	U
125	0605022D8Z	Defense Exportability Program	05				3,162		3,162	U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05				21,353		21,353	U
128	0605075D8Z	DCMO Policy and Integration	05				2,810		2,810	U
131	0605140D8Z	Trusted Foundry	05							U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05				11,870		11,870	U
133	0605294D8Z	Trusted & Assured Microelectronics	05				61,084		61,084	U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05				3,669		3,669	U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05				8,230		8,230	U
		System Development And Demonstration					341,821		341,821	

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101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04	3,768		3,768	U
102	0604775D8Z	Defense Rapid Innovation Program	04				U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04	3,104		3,104	U
		Advanced Component Development And Prototypes		2,019,673		2,019,673	
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05	8,333		8,333	U
119	0604165D8Z	Prompt Global Strike Capability Development	05	263,414		263,414	U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05	19,503		19,503	U
125	0605022D8Z	Defense Exportability Program	05	1,489		1,489	U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05	9,590		9,590	U
128	0605075D8Z	DCMO Policy and Integration	05	2,105		2,105	U
131	0605140D8Z	Trusted Foundry	05				U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05	6,374		6,374	U
133	0605294D8Z	Trusted & Assured Microelectronics	05	56,178		56,178	U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05	2,435		2,435	U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05	17,048		17,048	U
		System Development And Demonstration		386,469		386,469	

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137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06	4,672	6,941	6,941			U
138	0604875D8Z	Joint Systems Architecture Development	06	2,948	4,851	4,851			U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06	212,389	211,325	211,325			U
140	0604942D8Z	Assessments and Evaluations	06	27,626	30,144	30,144			U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06	65,062	91,057	91,057			U
143	0605104D8Z	Technical Studies, Support and Analysis	06	20,300	22,386	22,386			U
145	0605128D8Z	Classified Program USD(P)	06	130,000					U
146	0605142D8Z	Systems Engineering	06	31,276	37,622	37,622			U
147	0605151D8Z	Studies and Analysis Support - OSD	06	2,675	5,200	5,200			U
148	0605161D8Z	Nuclear Matters-Physical Security	06	5,101	5,232	5,232			U
149	0605170D8Z	Support to Networks and Information Integration	06	6,996	12,583	12,583			U
150	0605200D8Z	General Support to USD (Intelligence)	06	1,872	31,451	31,451			U
155	0605502D8Z	Small Business Innovative Research	06	84,770					U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06	2,185	2,372	2,372			U
160	0605798D8Z	Defense Technology Analysis	06	24,965	24,365	24,365			U

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137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06				6,941		6,941	U
138	0604875D8Z	Joint Systems Architecture Development	06				4,851		4,851	U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06				211,325		211,325	U
140	0604942D8Z	Assessments and Evaluations	06				30,144		30,144	U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06				91,057		91,057	U
143	0605104D8Z	Technical Studies, Support and Analysis	06				22,386		22,386	U
145	0605128D8Z	Classified Program USD(P)	06							U
146	0605142D8Z	Systems Engineering	06				37,622		37,622	U
147	0605151D8Z	Studies and Analysis Support - OSD	06				5,200		5,200	U
148	0605161D8Z	Nuclear Matters-Physical Security	06				5,232		5,232	U
149	0605170D8Z	Support to Networks and Information Integration	06				12,583		12,583	U
150	0605200D8Z	General Support to USD (Intelligence)	06	30,000	-30,000		61,451	-30,000	31,451	U
155	0605502D8Z	Small Business Innovative Research	06							U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06				2,372		2,372	U
160	0605798D8Z	Defense Technology Analysis	06				24,365		24,365	U

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137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06	6,661		6,661	U
138	0604875D8Z	Joint Systems Architecture Development	06	4,088		4,088	U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06	258,796		258,796	U
140	0604942D8Z	Assessments and Evaluations	06	31,356		31,356	U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06	84,184		84,184	U
143	0605104D8Z	Technical Studies, Support and Analysis	06	22,576		22,576	U
145	0605128D8Z	Classified Program USD(P)	06				U
146	0605142D8Z	Systems Engineering	06	38,872		38,872	U
147	0605151D8Z	Studies and Analysis Support - OSD	06	3,534		3,534	U
148	0605161D8Z	Nuclear Matters-Physical Security	06	5,050		5,050	U
149	0605170D8Z	Support to Networks and Information Integration	06	11,450		11,450	U
150	0605200D8Z	General Support to USD (Intelligence)	06	1,693		1,693	U
155	0605502D8Z	Small Business Innovative Research	06				U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06	2,545		2,545	U
160	0605798D8Z	Defense Technology Analysis	06	24,487		24,487	U

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163	0605804D8Z	Development Test and Evaluation	06	20,822	20,571	20,571			U
166	0606100D8Z	Budget and Program Assessments	06	3,863	3,992	3,992			U
167	0606225D8Z	ODNA Technology and Resource Analysis	06		1,000	1,000			U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06	2,070	2,551	2,551			U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06	843	1,006	1,006			U
178	0305193D8Z	Cyber Intelligence	06	10,511					U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06		18,992	18,992			U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06		1,231	1,231			U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06	29,149					U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06	437					U
		Management Support		690,532	534,872	534,872			
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07	15,584	10,882	10,882			U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07	4,035	7,222	7,222			U
208	0303140D8Z	Information Systems Security Program	07	8,560	9,415	9,415			U
224	0305186D8Z	Policy R&D Programs	07	3,120	6,526	6,526			U

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163	0605804D8Z	Development Test and Evaluation	06				20,571		20,571	U
166	0606100D8Z	Budget and Program Assessments	06				3,992		3,992	U
167	0606225D8Z	ODNA Technology and Resource Analysis	06				1,000		1,000	U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06				2,551		2,551	U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06				1,006		1,006	U
178	0305193D8Z	Cyber Intelligence	06							U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06				18,992		18,992	U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06				1,231		1,231	U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06							U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06							U
		Management Support		30,000	-30,000		564,872	-30,000	534,872	
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07				10,882		10,882	U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07				7,222		7,222	U
208	0303140D8Z	Information Systems Security Program	07				9,415		9,415	U
224	0305186D8Z	Policy R&D Programs	07				6,526		6,526	U

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163	0605804D8Z	Development Test and Evaluation	06	20,179		20,179	U
166	0606100D8Z	Budget and Program Assessments	06	5,768		5,768	U
167	0606225D8Z	ODNA Technology and Resource Analysis	06	1,030		1,030	U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06	3,008		3,008	U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06	1,005		1,005	U
178	0305193D8Z	Cyber Intelligence	06				U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06	109,529		109,529	U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06	1,244		1,244	U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06				U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06				U
		Management Support		637,055		637,055	
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07	10,376		10,376	U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07	5,915		5,915	U
208	0303140D8Z	Information Systems Security Program	07	7,940		7,940	U
224	0305186D8Z	Policy R&D Programs	07	6,262		6,262	U

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225	0305199D8Z	Net Centricity	07	17,357	18,455	18,455			U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07	7,052	2,071	2,071			U
240	0307577D8Z	Intelligence Mission Data (IMD)	07	13,485	13,111	13,111			U
		Operational System Development		69,193	67,682	67,682			
		Total Research, Development, Test & Eval, DW		4,084,372	4,041,233	4,041,233	25,000	25,000	

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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
225	0305199D8Z	Net Centricity	07				18,455		18,455	U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07				2,071		2,071	U
240	0307577D8Z	Intelligence Mission Data (IMD)	07				13,111		13,111	U
		Operational System Development					67,682		67,682	
		Total Research, Development, Test & Eval, DW		368,100	-368,100		4,434,333	-368,100	4,066,233	

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
225	0305199D8Z	Net Centricity	07	16,780		16,780	U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07	2,198		2,198	U
240	0307577D8Z	Intelligence Mission Data (IMD)	07	6,889		6,889	U
		Operational System Development		56,360		56,360	
		Total Research, Development, Test & Eval, DW		4,650,932	25,000	4,675,932	

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3	0601110D8Z	Basic Research Initiatives	01	66,750	40,612	40,612			U
5	0601120D8Z	National Defense Education Program	01	76,995	74,298	74,298			U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01	32,709	25,865	25,865			U
		Basic Research		176,454	140,775	140,775			
8	0602000D8Z	Joint Munitions Technology	02	17,611	19,111	19,111			U
10	0602230D8Z	Defense Technology Innovation	02	9,989					U
11	0602234D8Z	Lincoln Laboratory Research Program	02	46,500	49,748	49,748			U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02	40,798	49,226	49,226			U
16	0602668D8Z	Cyber Security Research	02	11,906	14,775	14,775			U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02	8,105	8,955	8,955			U
		Applied Research		134,909	141,815	141,815			
23	0603000D8Z	Joint Munitions Advanced Technology	03	23,742	25,627	25,627			U
24	0603122D8Z	Combating Terrorism Technology Support	03	113,366	76,230	76,230	25,000	25,000	U
25	0603133D8Z	Foreign Comparative Testing	03	18,966	24,199	24,199			U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03	16,618	18,662	18,662			U
36	0603288D8Z	Analytic Assessments	03	11,603	13,154	13,154			U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03	55,679	37,674	37,674			U

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3	0601110D8Z	Basic Research Initiatives	01				40,612		40,612	U
5	0601120D8Z	National Defense Education Program	01				74,298		74,298	U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01				25,865		25,865	U
		Basic Research					140,775		140,775	
8	0602000D8Z	Joint Munitions Technology	02				19,111		19,111	U
10	0602230D8Z	Defense Technology Innovation	02							U
11	0602234D8Z	Lincoln Laboratory Research Program	02				49,748		49,748	U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02				49,226		49,226	U
16	0602668D8Z	Cyber Security Research	02				14,775		14,775	U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02				8,955		8,955	U
		Applied Research					141,815		141,815	
23	0603000D8Z	Joint Munitions Advanced Technology	03				25,627		25,627	U
24	0603122D8Z	Combating Terrorism Technology Support	03				101,230		101,230	U
25	0603133D8Z	Foreign Comparative Testing	03				24,199		24,199	U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03				18,662		18,662	U
36	0603288D8Z	Analytic Assessments	03				13,154		13,154	U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03				37,674		37,674	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
3	0601110D8Z	Basic Research Initiatives	01	42,702		42,702	U
5	0601120D8Z	National Defense Education Program	01	85,919		85,919	U
6	0601228D8Z	Historically Black Colleges and Universities/Minority Institutions	01	30,412		30,412	U
		Basic Research		159,033		159,033	
8	0602000D8Z	Joint Munitions Technology	02	19,170		19,170	U
10	0602230D8Z	Defense Technology Innovation	02				U
11	0602234D8Z	Lincoln Laboratory Research Program	02	51,596		51,596	U
12	0602251D8Z	Applied Research for the Advancement of S&T Priorities	02	60,688		60,688	U
16	0602668D8Z	Cyber Security Research	02	14,969		14,969	U
21	0602751D8Z	Software Engineering Institute (SEI) Applied Research	02	9,300		9,300	U
		Applied Research		155,723		155,723	
23	0603000D8Z	Joint Munitions Advanced Technology	03	25,598		25,598	U
24	0603122D8Z	Combating Terrorism Technology Support	03	125,271	25,000	150,271	U
25	0603133D8Z	Foreign Comparative Testing	03	24,532		24,532	U
32	0603225D8Z	Joint DoD-DoE Munitions Technology Development	03	18,644		18,644	U
36	0603288D8Z	Analytic Assessments	03	19,472		19,472	U
37	0603289D8Z	Advanced Innovative Analysis and Concepts	03	37,263		37,263	U

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38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03		15,000	15,000			U
41	0603375D8Z	Technology Innovation	03	24,895	59,863	59,863			U
43	0603527D8Z	RETRACT LARCH	03	175,135	171,120	171,120			U
44	0603618D8Z	Joint Electronic Advanced Technology	03	21,376	14,389	14,389			U
45	0603648D8Z	Joint Capability Technology Demonstrations	03	127,961	105,871	105,871			U
46	0603662D8Z	Networked Communications Capabilities	03	9,123	12,661	12,661			U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03	177,419	136,159	136,159			U
49	0603699D8Z	Emerging Capabilities Technology Development	03	54,279	57,876	57,876			U
52	0603716D8Z	Strategic Environmental Research Program	03	63,177	71,832	71,832			U
54	0603727D8Z	Joint Warfighting Program	03	4,581	6,349	6,349			U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03	10,384	11,211	11,211			U
60	0603781D8Z	Software Engineering Institute	03	13,726	15,047	15,047			U
61	0603826D8Z	Quick Reaction Special Projects	03	77,354	69,203	69,203			U
62	0603833D8Z	Engineering Science & Technology	03	22,198	25,395	25,395			U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03						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	S e c
38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03				15,000		15,000	U
41	0603375D8Z	Technology Innovation	03	5,000	-5,000		64,863	-5,000	59,863	U
43	0603527D8Z	RETRACT LARCH	03				171,120		171,120	U
44	0603618D8Z	Joint Electronic Advanced Technology	03				14,389		14,389	U
45	0603648D8Z	Joint Capability Technology Demonstrations	03				105,871		105,871	U
46	0603662D8Z	Networked Communications Capabilities	03				12,661		12,661	U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03				136,159		136,159	U
49	0603699D8Z	Emerging Capabilities Technology Development	03				57,876		57,876	U
52	0603716D8Z	Strategic Environmental Research Program	03				71,832		71,832	U
54	0603727D8Z	Joint Warfighting Program	03				6,349		6,349	U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03				11,211		11,211	U
60	0603781D8Z	Software Engineering Institute	03				15,047		15,047	U
61	0603826D8Z	Quick Reaction Special Projects	03				69,203		69,203	U
62	0603833D8Z	Engineering Science & Technology	03				25,395		25,395	U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03							U

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38	0603291D8Z	Advanced Innovative Analysis and Concepts - MHA	03	13,621		13,621	U
41	0603375D8Z	Technology Innovation	03	83,143		83,143	U
43	0603527D8Z	RETRACT LARCH	03	161,128		161,128	U
44	0603618D8Z	Joint Electronic Advanced Technology	03	12,918		12,918	U
45	0603648D8Z	Joint Capability Technology Demonstrations	03	106,049		106,049	U
46	0603662D8Z	Networked Communications Capabilities	03	12,696		12,696	U
47	0603680D8Z	Defense-Wide Manufacturing Science and Technology Program	03	114,637		114,637	U
49	0603699D8Z	Emerging Capabilities Technology Development	03	48,338		48,338	U
52	0603716D8Z	Strategic Environmental Research Program	03	76,514		76,514	U
54	0603727D8Z	Joint Warfighting Program	03	5,992		5,992	U
59	0603769D8Z	Distributed Learning Advanced Technology Development	03	13,564		13,564	U
60	0603781D8Z	Software Engineering Institute	03	15,050		15,050	U
61	0603826D8Z	Quick Reaction Special Projects	03	69,626		69,626	U
62	0603833D8Z	Engineering Science & Technology	03	19,415		19,415	U
63	0603924D8Z	High Energy Laser Advanced Technology Program	03	69,533		69,533	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
64	0603941D8Z	Test & Evaluation Science & Technology	03	89,605	89,586	89,586			U
65	0604055D8Z	Operational Energy Capability Improvement	03	41,459	38,403	38,403			U
66	0303310D8Z	CWMD Systems	03	19,587	33,382	33,382			U
		Advanced Technology Development		1,172,233	1,128,893	1,128,893	25,000	25,000	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04	25,851	32,937	32,937			U
69	0603600D8Z	WALKOFF	04	96,038	101,714	101,714			U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04	1,761	2,198	2,198			U
71	0603851D8Z	Environmental Security Technical Certification Program	04	46,440	54,583	54,583			U
89	0603920D8Z	Humanitarian Demining	04	9,740	10,837	10,837			U
90	0603923D8Z	Coalition Warfare	04	9,789	10,740	10,740			U
91	0604016D8Z	Department of Defense Corrosion Program	04	14,394	3,837	3,837			U
93	0604132D8Z	Missile Defeat Project	04	138,350	98,369	98,369			U
96	0604250D8Z	Advanced Innovative Technologies	04	850,762	1,175,832	1,175,832			U
97	0604294D8Z	Trusted & Assured Microelectronics	04		83,626	83,626			U
98	0604331D8Z	Rapid Prototyping Program	04	100,000	100,000	100,000			U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04	7,254	3,967	3,967			U

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64	0603941D8Z	Test & Evaluation Science & Technology	03				89,586		89,586	U
65	0604055D8Z	Operational Energy Capability Improvement	03				38,403		38,403	U
66	0303310D8Z	CWMD Systems	03				33,382		33,382	U
		Advanced Technology Development		5,000	-5,000		1,158,893	-5,000	1,153,893	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04				32,937		32,937	U
69	0603600D8Z	WALKOFF	04				101,714		101,714	U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04				2,198		2,198	U
71	0603851D8Z	Environmental Security Technical Certification Program	04				54,583		54,583	U
89	0603920D8Z	Humanitarian Demining	04				10,837		10,837	U
90	0603923D8Z	Coalition Warfare	04				10,740		10,740	U
91	0604016D8Z	Department of Defense Corrosion Program	04				3,837		3,837	U
93	0604132D8Z	Missile Defeat Project	04	26,400	-26,400		124,769	-26,400	98,369	U
96	0604250D8Z	Advanced Innovative Technologies	04	306,700	-306,700		1,482,532	-306,700	1,175,832	U
97	0604294D8Z	Trusted & Assured Microelectronics	04				83,626		83,626	U
98	0604331D8Z	Rapid Prototyping Program	04				100,000		100,000	U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04				3,967		3,967	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
64	0603941D8Z	Test & Evaluation Science & Technology	03	96,389		96,389	U
65	0604055D8Z	Operational Energy Capability Improvement	03	40,582		40,582	U
66	0303310D8Z	CWMD Systems	03	26,644		26,644	U
		Advanced Technology Development		1,236,619	25,000	1,261,619	
68	0603161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E ADC&P	04	28,140		28,140	U
69	0603600D8Z	WALKOFF	04	92,222		92,222	U
70	0603821D8Z	Acquisition Enterprise Data & Information Services	04	2,506		2,506	U
71	0603851D8Z	Environmental Security Technical Certification Program	04	40,016		40,016	U
89	0603920D8Z	Humanitarian Demining	04	11,347		11,347	U
90	0603923D8Z	Coalition Warfare	04	8,528		8,528	U
91	0604016D8Z	Department of Defense Corrosion Program	04	3,477		3,477	U
93	0604132D8Z	Missile Defeat Project	04	58,607		58,607	U
96	0604250D8Z	Advanced Innovative Technologies	04	1,431,702		1,431,702	U
97	0604294D8Z	Trusted & Assured Microelectronics	04	233,142		233,142	U
98	0604331D8Z	Rapid Prototyping Program	04	99,333		99,333	U
99	0604400D8Z	Department of Defense (DoD) Unmanned System Common Development	04	3,781		3,781	U

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101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04	3,850	3,833	3,833			U
102	0604775D8Z	Defense Rapid Innovation Program	04	250,000					U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04	2,633	2,902	2,902			U
		Advanced Component Development And Prototypes		1,556,862	1,685,375	1,685,375			
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05	10,152	12,536	12,536			U
119	0604165D8Z	Prompt Global Strike Capability Development	05	161,100	201,749	201,749			U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05	15,691	15,358	15,358			U
125	0605022D8Z	Defense Exportability Program	05	2,853	3,162	3,162			U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05	16,131	21,353	21,353			U
128	0605075D8Z	DCMO Policy and Integration	05		2,810	2,810			U
131	0605140D8Z	Trusted Foundry	05	67,252					U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05	8,310	11,870	11,870			U
133	0605294D8Z	Trusted & Assured Microelectronics	05		61,084	61,084			U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05	2,700	3,669	3,669			U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05		8,230	8,230			U
		System Development And Demonstration		284,189	341,821	341,821			

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101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04				3,833		3,833	U
102	0604775D8Z	Defense Rapid Innovation Program	04							U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04				2,902		2,902	U
		Advanced Component Development And Prototypes		333,100	-333,100		2,018,475	-333,100	1,685,375	
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05				12,536		12,536	U
119	0604165D8Z	Prompt Global Strike Capability Development	05				201,749		201,749	U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05				15,358		15,358	U
125	0605022D8Z	Defense Exportability Program	05				3,162		3,162	U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05				21,353		21,353	U
128	0605075D8Z	DCMO Policy and Integration	05				2,810		2,810	U
131	0605140D8Z	Trusted Foundry	05							U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05				11,870		11,870	U
133	0605294D8Z	Trusted & Assured Microelectronics	05				61,084		61,084	U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05				3,669		3,669	U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05				8,230		8,230	U
		System Development And Demonstration					341,821		341,821	

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Appropriation: 0400D Research, Development, Test & Eval, DW

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
101	0604682D8Z	Wargaming and Support for Strategic Analysis (SSA)	04	3,768		3,768	U
102	0604775D8Z	Defense Rapid Innovation Program	04				U
114	0303191D8Z	Joint Electromagnetic Technology (JET) Program	04	3,104		3,104	U
		Advanced Component Development And Prototypes		2,019,673		2,019,673	
118	0604161D8Z	Nuclear and Conventional Physical Security Equipment RDT&E SDD	05	8,333		8,333	U
119	0604165D8Z	Prompt Global Strike Capability Development	05	263,414		263,414	U
121	0604771D8Z	Joint Tactical Information Distribution System (JTIDS)	05	19,503		19,503	U
125	0605022D8Z	Defense Exportability Program	05	1,489		1,489	U
126	0605027D8Z	OUSD(C) IT Development Initiatives	05	9,590		9,590	U
128	0605075D8Z	DCMO Policy and Integration	05	2,105		2,105	U
131	0605140D8Z	Trusted Foundry	05				U
132	0605210D8Z	Defense-Wide Electronic Procurement Capabilities	05	6,374		6,374	U
133	0605294D8Z	Trusted & Assured Microelectronics	05	56,178		56,178	U
135	0305304D8Z	DoD Enterprise Energy Information Management (EEIM)	05	2,435		2,435	U
136	0305310D8Z	CWMD Systems: System Development and Demonstration	05	17,048		17,048	U
		System Development And Demonstration		386,469		386,469	

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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
137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06	4,672	6,941	6,941			U
138	0604875D8Z	Joint Systems Architecture Development	06	2,948	4,851	4,851			U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06	212,389	211,325	211,325			U
140	0604942D8Z	Assessments and Evaluations	06	27,626	30,144	30,144			U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06	65,062	91,057	91,057			U
143	0605104D8Z	Technical Studies, Support and Analysis	06	20,300	22,386	22,386			U
145	0605128D8Z	Classified Program USD(P)	06	130,000					U
146	0605142D8Z	Systems Engineering	06	31,276	37,622	37,622			U
147	0605151D8Z	Studies and Analysis Support - OSD	06	2,675	5,200	5,200			U
148	0605161D8Z	Nuclear Matters-Physical Security	06	5,101	5,232	5,232			U
149	0605170D8Z	Support to Networks and Information Integration	06	6,996	12,583	12,583			U
150	0605200D8Z	General Support to USD (Intelligence)	06	1,872	31,451	31,451			U
155	0605502D8Z	Small Business Innovative Research	06	84,770					U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06	2,185	2,372	2,372			U
160	0605798D8Z	Defense Technology Analysis	06	24,965	24,365	24,365			U

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137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06				6,941		6,941	U
138	0604875D8Z	Joint Systems Architecture Development	06				4,851		4,851	U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06				211,325		211,325	U
140	0604942D8Z	Assessments and Evaluations	06				30,144		30,144	U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06				91,057		91,057	U
143	0605104D8Z	Technical Studies, Support and Analysis	06				22,386		22,386	U
145	0605128D8Z	Classified Program USD(P)	06							U
146	0605142D8Z	Systems Engineering	06				37,622		37,622	U
147	0605151D8Z	Studies and Analysis Support - OSD	06				5,200		5,200	U
148	0605161D8Z	Nuclear Matters-Physical Security	06				5,232		5,232	U
149	0605170D8Z	Support to Networks and Information Integration	06				12,583		12,583	U
150	0605200D8Z	General Support to USD (Intelligence)	06	30,000	-30,000		61,451	-30,000	31,451	U
155	0605502D8Z	Small Business Innovative Research	06							U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06				2,372		2,372	U
160	0605798D8Z	Defense Technology Analysis	06				24,365		24,365	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
137	0604774D8Z	Defense Readiness Reporting System (DRRS)	06	6,661		6,661	U
138	0604875D8Z	Joint Systems Architecture Development	06	4,088		4,088	U
139	0604940D8Z	Central Test and Evaluation Investment Development (CTEIP)	06	258,796		258,796	U
140	0604942D8Z	Assessments and Evaluations	06	31,356		31,356	U
142	0605100D8Z	Joint Mission Environment Test Capability (JMETC)	06	84,184		84,184	U
143	0605104D8Z	Technical Studies, Support and Analysis	06	22,576		22,576	U
145	0605128D8Z	Classified Program USD(P)	06				U
146	0605142D8Z	Systems Engineering	06	38,872		38,872	U
147	0605151D8Z	Studies and Analysis Support - OSD	06	3,534		3,534	U
148	0605161D8Z	Nuclear Matters-Physical Security	06	5,050		5,050	U
149	0605170D8Z	Support to Networks and Information Integration	06	11,450		11,450	U
150	0605200D8Z	General Support to USD (Intelligence)	06	1,693		1,693	U
155	0605502D8Z	Small Business Innovative Research	06				U
159	0605790D8Z	Small Business Innovation Research (SBIR)/ Small Business Technology Transfer	06	2,545		2,545	U
160	0605798D8Z	Defense Technology Analysis	06	24,487		24,487	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	S e c
163	0605804D8Z	Development Test and Evaluation	06	20,822	20,571	20,571			U
166	0606100D8Z	Budget and Program Assessments	06	3,863	3,992	3,992			U
167	0606225D8Z	ODNA Technology and Resource Analysis	06		1,000	1,000			U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06	2,070	2,551	2,551			U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06	843	1,006	1,006			U
178	0305193D8Z	Cyber Intelligence	06	10,511					U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06		18,992	18,992			U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06		1,231	1,231			U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06	29,149					U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06	437					U
		Management Support		690,532	534,872	534,872			
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07	15,584	10,882	10,882			U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07	4,035	7,222	7,222			U
208	0303140D8Z	Information Systems Security Program	07	8,560	9,415	9,415			U
224	0305186D8Z	Policy R&D Programs	07	3,120	6,526	6,526			U

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163	0605804D8Z	Development Test and Evaluation	06				20,571		20,571	U
166	0606100D8Z	Budget and Program Assessments	06				3,992		3,992	U
167	0606225D8Z	ODNA Technology and Resource Analysis	06				1,000		1,000	U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06				2,551		2,551	U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06				1,006		1,006	U
178	0305193D8Z	Cyber Intelligence	06							U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06				18,992		18,992	U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06				1,231		1,231	U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06							U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06							U
		Management Support		30,000	-30,000		564,872	-30,000	534,872	
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07				10,882		10,882	U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07				7,222		7,222	U
208	0303140D8Z	Information Systems Security Program	07				9,415		9,415	U
224	0305186D8Z	Policy R&D Programs	07				6,526		6,526	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
163	0605804D8Z	Development Test and Evaluation	06	20,179		20,179	U
166	0606100D8Z	Budget and Program Assessments	06	5,768		5,768	U
167	0606225D8Z	ODNA Technology and Resource Analysis	06	1,030		1,030	U
171	0203345D8Z	Defense Operations Security Initiative (DOSI)	06	3,008		3,008	U
176	0303260D8Z	Defense Military Deception Program Office (DMDPO)	06	1,005		1,005	U
178	0305193D8Z	Cyber Intelligence	06				U
180	0305245D8Z	Intelligence Capabilities and Innovation Investments	06	109,529		109,529	U
181	0306310D8Z	CWMD Systems: RDT&E Management Support	06	1,244		1,244	U
182	0804767D8Z	COCOM Exercise Engagement and Training Transformation (CE2T2) - MHA	06				U
188	0909999D8Z	Financing for Cancelled Account Adjustments	06				U
		Management Support		637,055		637,055	
192	0607210D8Z	Industrial Base Analysis and Sustainment Support	07	10,376		10,376	U
193	0607310D8Z	CWMD Systems: Operational Systems Development	07	5,915		5,915	U
208	0303140D8Z	Information Systems Security Program	07	7,940		7,940	U
224	0305186D8Z	Policy R&D Programs	07	6,262		6,262	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
225	0305199D8Z	Net Centricity	07	17,357	18,455	18,455			U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07	7,052	2,071	2,071			U
240	0307577D8Z	Intelligence Mission Data (IMD)	07	13,485	13,111	13,111			U
		Operational System Development		69,193	67,682	67,682			
		Total Office of Secretary of Defense		4,084,372	4,041,233	4,041,233	25,000	25,000	

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225	0305199D8Z	Net Centricity	07				18,455		18,455	U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07				2,071		2,071	U
240	0307577D8Z	Intelligence Mission Data (IMD)	07				13,111		13,111	U
		Operational System Development					67,682		67,682	
		Total Office of Secretary of Defense		368,100	-368,100		4,434,333	-368,100	4,066,233	

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
225	0305199D8Z	Net Centricity	07	16,780		16,780	U
234	0305387D8Z	Homeland Defense Technology Transfer Program	07	2,198		2,198	U
240	0307577D8Z	Intelligence Mission Data (IMD)	07	6,889		6,889	U
		Operational System Development		56,360		56,360	
		Total Office of Secretary of Defense		4,650,932	25,000	4,675,932	

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Listing of Acronyms

ACRONYM	DEFINITION
ARDEC	Army Armament Research, Development, and Engineering Center
AMRDEC	Aviation and Missile Research, Development, and Engineering Center
ASD/R&E	Assistant Secretary of Defense for Research and Engineering
ASW	Anti-Submarine Warfare
AT&L	Acquisition Technology and Logistics
C2	Command and Control
C3	Command, Controls, and Communications
C4	Command, Controls, Communications, and Computer
C4I	Command, Controls, Communications, Computer, and Intelligence
C4ISR	Command, Controls, Communications, Computer, Intelligence, Surveillance and Reconnaissance
C4IAS	Command, Controls, Communications, Computer, and Intelligence Automation System
CBRNE	Chemical, Biological, Radiological, Nuclear, and high-yield Explosives
CIED	Counter-Improvised Explosive Device
CND	Computer Network Defense
COCOMs	Combatant Commands
CTTSO	Combating Terrorism Technical Support Office
CWMD	Countering Weapons of Mass Destruction
DARPA	Defense Advanced Research Projects Agency
DIUx	Defense Innovation Unit Experimental
DOD	Department of Defense
DPPG	Defense Policy and Planning Guidance
DSCS	Defense Satellite Communications System
DTRA	Defense Threat Reduction Agency
DTRMC	Defense Test Resource Management Center
DT&E	Development, Test and Evaluation
EDTC	Engineering and Development Test Center
EMP	Electromagnetic Pulse
EMREP	Electromagnetic Reliability and Effects Predictions
EOD	Explosive Ordnance Disposal
EOD/LIC	Explosive Ordnance Disposal/Low-Intensity Conflict
ESTCP	Environmental Security Technology Certification Program
FATGS	Fuze Area Technology Groups
FCT	Foreign Comparative Testing
FFRDC	FFRDC Federally Funded Research and Development Center
GCC	Global Command and Control

GEF	Guidance for Employment of the Force
GKMC	Global Knowledge Management System
GSA	Global Situational Awareness
GSM	Global System for Mobile Communications
HAMMER	Heated and Mobile Munitions Employing RocketsHANE High Altitude Nuclear Environments
HARP	High Altitude Radiological Phenomenology
HEBX	Hybridized Enhanced Blast Explosive
HEMP	HEMP High Altitude Electro Magnetic Pulse
HBCU/MI	Historically Black Colleges and Universities and Minority Institutions
HDBT	Hard and Deeply Buried Target
HPAC	Hazard Prediction and Assessment Capability
HPCMP	High Performance Computing Modernization Program
HSBC	Human Social Culture Behavior
HTD	Hard Target Defeat
IBRD	Interagency Biological Restoration Demonstration
IED	Improvised Explosive Device
IM	Insensitive Munitions
IMD	Intelligence Mission Data
IMEA	Integrated Munitions Effects Assessment
IOC	Initial Operational Capability
IoT	Internet of Things
IPODS	Integrated Precision Ordnance Delivery System
ISR	Intelligence, Surveillance, Reconnaissance
ISS	Integrated Sensor System
ISSP	Information Systems Security Program
IWS	Irregular Warfare Support
ITD	Integrated Technology Demonstration
JCIDS	Joint Capabilities Integration and Development System
JCTD	Joint Concept Technology Demonstration
JEM	Joint Effects Model
JFTP	Joint Fuze Technology Program
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JIMTP	Joint Insensitive Munitions Technology Program
JMEWS	Joint Multi-Effects Warhead System
JSAF	Joint Semi-Automated Forces
JUON/JEON	Joint Urgent Operational Needs / Joint Emergent Operational Needs
M&S	Modeling and Simulation
MATGs	Munition Area Technology Groups

MDDE	Missile Defeat Defense Enhancement
MEMS	MEMS - MicroElectro-Mechanical Systems (MEMS)
MCPP	Military Child Pilot Program
MIL STD	Military Standard
MRL	MRL - Manufacturing Readiness Level
NDAA	National Defense Authorization Act
NDEP	National Defense Education Program
NCNS	National Center for Nuclear Security
NMCC	National Military Command Center
NNSA	National Nuclear Security Administration
NSSEFF	National Security Science and Engineering Faculty Fellowship
NuCS	Nuclear Capability Services
NWC	Nuclear Weapons Council
NWE	Nuclear Weapon Effects
NWEN	Nuclear Weapon Effects Network
NWEDS	Nuclear Weapons Effects Database System
NWRM	Nuclear Weapons Related Materiel
OCO	Overseas Contingency Operations
OCONUS	Outside the Continental United States
OLED	Organic Light Emitting Diode
OSD	Office of the Secretary of Defense
OSTP	Office of Science and Technology Policy
PDV	Product Demonstration Vehicle
PEO	Program Executive Officers
QDR	Quadrennial Defense Review
R2TD	Rapid Reaction Tunnel Detection
RDT&E	Research Development Test and Evaluation
RadHard	Radiation Hardened
RFIS	Robust Fuzewell Instrumentation System
RHBD	Radiation Hardened by Design
RHM	Radiation Hardened Microelectronics
ROI	Return on Investments
ROM	Rough Order of Magnitude
S&E	Scientists and Engineers
S&T	Science & Technology
SBIR	Small Business Innovative Research
SCO	Strategic Capabilities Office
SCSP	Special Operations Command Combating Weapons of Mass Destruction-Terrorism Support Program

Listing of Acronyms

SMART	Science, Mathematics, and Research for Transformation
SMDC	Space and Missile Development Command
SNL	Sandia National Laboratory
SNM	Special Nuclear Material
SOF	Special Operations Forces
SPE	Source Physics Experiment
SPG	Short Pulse Gamma
SSBR	Strategic Support for Basic Research
STEM	Science, Technology, Engineering, and Mathematics
STTR	Small Business Technology Transfer
TB	Test Bed
TEAMS	Technical Evaluation Assessment and Monitor Site
TNF	Technical Nuclear Forensics
TOA	Total Obligation Authority
TOW	Tube-launched, Optically-tracked, Wireless-guided
TPMM	TPMM Technology Program Management Model
TRAC	Threat Reduction Advisory Committee
TRL	Technology Readiness Level
TSG	Technical Support Group
UAS	Unmanned Aerial Systems
UCP	Unified Command Plan
UGF	Underground Facility
UGT	UGT Underground Test
USFK	U.S. Forces Korea
USG	USG United States Government
USNORTHCOM	U.S. Northern Command
USPACOM	U.S. Pacific Command
USSOCOM	U.S. Special Operations Command
USSTRATCOM	U.S. Strategic Command
UTAS	Underground Targeting and Analysis System
UXO	Unexploded Ordnance
WACS	WMD Aerial Collection System
WCF	West Coast Facility
WEP	Weapon Effects Phenomenology
WESC	Weapon Effects Steering Committee
WMD	Weapons of Mass Destruction
WSMR	White Sands Missile Range

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*

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	-	66.750	40.612	42.702	-	42.702	45.253	46.074	46.862	47.749	Continuing	Continuing
010: *Basic Research Initiatives*	-	44.530	12.444	13.085	-	13.085	13.866	14.118	14.360	14.631	Continuing	Continuing
060: *Vannevar Bush Faculty Fellowship*	-	22.220	28.168	29.617	-	29.617	31.387	31.956	32.502	33.118	Continuing	Continuing

A. Mission Description and Budget Item Justification

Supporting basic research provides the Department of Defense (DoD) with a deep and broad awareness of current directions in areas of research important to U.S. military capabilities – including physics and the physical sciences, materials science, chemistry and chemical engineering, electrical engineering, mathematics, computer science, mechanical and aerodynamic engineering, ocean sciences, biological sciences, and the social sciences, among others. Basic research sustains scientific and engineering communities as it generates the critical technical underpinnings of DoD capabilities. Basic research allows exploration and discovery, yielding disruptive non-incremental advances that can improve or radically change military capabilities, strategy, and operations.

The Basic Research Initiatives program element (PE) supports the defense basic research enterprise in three critical areas: Strategic Support for Basic Research (SSBR), the Minerva Research Initiative, and the Vannevar Bush Faculty Fellowship Program (Vannevar Bush), formerly known as the National Security Science and Engineering Faculty Fellowship (NSSEFF) program.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	36.654	40.612	43.006	-	43.006
Current President's Budget	66.750	40.612	42.702	-	42.702
Total Adjustments	30.096	0.000	-0.304	-	-0.304
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	31.500	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.324	-			
• FFRDC Transfer	-0.075	-	-	-	-
• Other Program Adjustments	-0.005	-	-0.017	-	-0.017
• Economic Assumption Inflation Adjustment	-	-	-0.287	-	-0.287

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2017**	**FY 2018**
Project: 010: *Basic Research Initiatives*		
Congressional Add: *Program Increase*	31.500	-
Congressional Add Subtotals for Project: 010	31.500	-
Congressional Add Totals for all Projects	31.500	-

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 010 / *Basic Research Initiatives*	

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
010: *Basic Research Initiatives*	-	44.530	12.444	13.085	-	13.085	13.866	14.118	14.360	14.631	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Basic Research Initiatives project code, P010, includes Strategic Support for Basic Research (SSBR) and the Minerva Research Initiative.

SSBR supports oversight, policies, and initiatives to implement the Under Secretary of Defense for Research and Engineering's (USD(R&E)) strategic plan for defense basic research. This plan defines actions to help create conditions for defense basic research investments capable of producing high-payoff, transformative scientific breakthroughs for the Department. SSBR initiatives support the five Basic Research Office strategic goals: (1) drive the direction of DoD basic research investments; (2) coordinate and conduct oversight of DoD basic research programs; (3) improve the science and engineering (S&E) workforce and public outreach; (4) enhance university-industry collaboration; and (5) engage with the academic research community and international partners.

The Minerva Research Initiative, a department-wide basic research program in the social sciences directed by the Office of the Secretary of Defense (OSD) and executed by the Services, seeks to build a fundamental understanding of the sources of present and future conflict. It is one of the Nation's only social science basic research programs in support of national security. Minerva promotes a deeper understanding of the social and cultural environments, where threats such as radicalization and regional instabilities develop, and supports more effective strategic and operational policy decisions. Minerva program priorities are consistent with the goals set forth in the 2014 Quadrennial Defense Review (QDR), informing DoD efforts to effectively build security globally, and are updated annually according to inputs from across the defense enterprise.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Strategic Support for Basic Research (SSBR) ***Description:*** The SSBR program creates conditions for defense basic research investments capable of producing high-payoff, transformative scientific breakthroughs for the Department. SSBR initiatives support the five Basic Research Office strategic goals: (1) drive the direction of DoD basic research investments; (2) coordinate and conduct oversight of DoD basic research programs; (3) improve the science and engineering (S&E) workforce and public outreach; (4) enhance university-industry collaboration; and (5) engage with the academic research community and international partners. ***FY 2018 Plans:*** Conduct four to six workshops for scientific situational awareness that were planned in previous fiscal years. Convene national research leaders to provide expert perspectives on potential breakthroughs and barriers of advancement in rapidly evolving fields of basic research. Continue studies of how past DoD investments and high priority basic research has led to advances in new technologies and new capabilities for the Nation. As part of the USD(R&E) mission, continue to analyze university-related business practices for improvement and efficiency. Continue support for scientific expertise to oversee science and engineering initiatives. Evaluate the effectiveness of the Defense Enterprise Scientific Initiative (DESI) and Innovative-Corps (I-	1.973	2.235	2.312

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 010 / *Basic Research Initiatives*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Corps) pilot programs. Organize the Science, Technology, and Innovation Exchange (STIx) #conference to increase awareness of department-wide basic research programs. ***FY 2019 Plans:*** Conduct four to six workshops for scientific situational awareness that were planned in previous fiscal years. Convene national research leaders to provide expert perspectives on potential breakthroughs and barriers of advancement in rapidly evolving fields of basic research. Continue studies of how past DoD investments and high priority basic research has led to advances in new technologies and new capabilities for the Nation. As part of the USD(R&E) mission, continue to analyze university-related business practices for improvement and efficiency. Continue support for scientific expertise to oversee science and engineering initiatives. Evaluate effectiveness of DESI and I-Corps pilot programs. Organize the STIx #conference to increase awareness of department-wide basic research programs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY 2018 to FY 2019 supports SSBR workshops and studies.			
Title: Minerva Research Initiative ***Description:*** The Minerva Research Initiative includes three primary components: (1) a university-based social science basic research grant program; (2) the Research for Defense Education Faculty (R-DEF) program for the professional military education (PME) institutions; and (3) a collaboration with the Congressionally-established United States Institute of Peace to award research support to advanced graduate students and early career scholars working on security and peace. All components contribute to Minerva's goals of revitalizing connections between DoD and academic social science communities and building cultural and foreign area knowledge on topics ranging from the mechanisms of radicalization to geopolitical power projection strategies in a multi-polar world. This deeper scientific understanding will provide a more informed basis to shape doctrine, analysis, and other strategic and operational decisions made by war planners and warfighters. ***FY 2018 Plans:*** Execute 12-14 new university-led research projects and continue support for successful ongoing projects, with priorities shaped by defense needs. Maintain support of R-DEF program at defense education institutions. Continue active engagement to provide subject matter expertise to the operational community through the annual Minerva Conference. Continue to build policy and operational community connections to effectively connect new social science discoveries and analytical methods to current and future defense leadership and to inform tomorrow's key security decisions. ***FY 2019 Plans:*** Continue to support successful ongoing university-led research projects and execute 12-14 new projects based on input from DoD stakeholders. Encourage more partnerships between university-led and R-DEF projects and continue support for R-DEF program. Continue active engagement with operational community by providing subject matter expertise on request and through the annual Minerva Conference and outreach to DoD stakeholders. Retain existing and generate new connections to policy and	11.057	10.209	10.773

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 010 / *Basic Research Initiatives*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
operational communities to facilitate the transition of Minerva research. Effectively connect new social science discoveries and analytical methods to current and future defense leadership and to inform future security decisions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY 2018 to FY 2019 supports university-led research projects within the Minerva Research Initiative.			
Accomplishments/Planned Programs Subtotals	13.030	12.444	13.085

	FY 2017	**FY 2018**
Congressional Add: Program Increase	31.500	-
FY 2017 Accomplishments: Hosted the inaugural Science, Technology, and Innovation Exchange (STIx) conference in August 2018. This conference brought together DoD-funded researchers, including Vannevar Bush Faculty Fellows, National Defense Science and Engineering Graduate (NDSEG) Fellows, and Science, Mathematics, and Research for Transformation (SMART) Fellows, as well as university faculty researchers together with defense laboratory scientists and program managers from the Services and the Defense Advanced Research Projects Agency. STIx showcased and connected the nation's brightest minds to communicate new ideas and share novel approaches to confronting old challenges facing the defense community. Its Ted-like lightening talks were streamed online over two days and are posted on the web. Planned and published a broad agency announcement for the Defense Enterprise Scientific Initiative (DESI) pilot program with assistance from the Air Force Office of Scientific Research in August 2017. DESI was funded through the FY 2017 plus-up. The program aims to inspire the collaboration among universities and industries in fundamental research. Executed the first competition for the I-Corps @ DoD Commercialization pilot program, and supported 6 teams established in FY 2016. One team received follow-on private capital to commercialize their research and another received the most improved award from the National Science Foundation's I-Corps teaching team. The second competition is currently underway and will fund up to 12 teams. Selected ten laboratory scientists for the 2017 class of Laboratory University Collaboration Initiative (LUCI) Fellows. The research topics included advanced manufacturing, robotics, data analytics, optics and novel engineering materials. The awardees included NDSEG and SMART Fellowship recipients. Organized the first review of the LUCI program in collaboration with the Army Research Laboratory in September 2017.		
Congressional Adds Subtotals	31.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 010 / *Basic Research Initiatives*

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 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 060 / *Vannevar Bush Faculty Fellowship*

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
060: *Vannevar Bush Faculty Fellowship*	-	22.220	28.168	29.617	-	29.617	31.387	31.956	32.502	33.118	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Vannevar Bush Faculty Fellowship, formerly the National Security Science and Engineering Faculty Fellowship (NSSEFF), program supports world-class researchers in scientific areas of critical importance to DoD and ensures the cultivation of exceptional talent. Fellows' research spans a broad set of emerging scientific areas with transformative potential, including Quantum Information Science, Novel Engineered Materials, Cognitive Neuroscience, Engineering Biology, Robotics, Data Analytics, and others. The program fosters close connections between academia and the defense science and engineering enterprise, a primary goal of SSBR efforts. Fellows provide the Department the deep scientific expertise from today's leading research universities and collaborate with defense scientists and engineers. This program actively engages and coordinates basic research across the Department.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Vannevar Bush Faculty Fellowship (Vannevar Bush) Program ***Description:*** The Vannevar Bush Program ensures the DoD has a research portfolio that supports creative, innovative, and productive university researchers. The objectives of the program are to: (1) support scientific research that may lead to extraordinary outcomes; (2) educate and train student and post-doctoral researchers for the defense and national security workforce; (3) foster long-term relationships between university researchers and the Department; (4) familiarize select university researchers and their students with DoD's current and future challenges; and (5) increase the number of exceptionally talented technical experts that are contributing to DoD's mission. ***FY 2018 Plans:*** Provide support to 45 Vannevar Bush Fellows and support collaboration on research with 26 Laboratory University Collaboration Initiative (LUCI) Fellows from DoD Service Laboratories. Review and update program focus topic areas with input from DoD science and technology (S&T) community. Organize and execute a competition to select a new class of Vannevar Bush Fellows. Organize and conduct the Vannevar Bush annual meeting, including DoD laboratory tours. Identify and facilitate connections between new Fellows and DoD scientists and engineers, including the Vannevar Bush Steering Committee. Organize and conduct a program review and site visits to monitor the research progress by Vannevar Bush Fellows and their DoD collaborators. Conduct review of LUCI projects in DoD laboratories and report the scientific progress and impacts. ***FY 2019 Plans:*** Support 47 Vannevar Bush Fellows and collaboration on their research with ten LUCI Fellows from DoD Service Laboratories. Review and update program focus topic areas with input from DoD S&T community. Organize and execute a competition to select a new class of Vannevar Bush Fellows. Organize and conduct the Vannevar Bush annual meeting, including DoD laboratory tours. Facilitate connections between new Fellows and DoD scientists and engineers, including the Vannevar Bush Steering	22.220	28.168	29.617

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601110D8Z / *Basic Research Initiatives*	**Project (Number/Name)** 060 / *Vannevar Bush Faculty Fellowship*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Committee. Organize and conduct a program review and site visits to monitor the research progress by Vannevar Bush Fellows and their DoD collaborators. Conduct review of LUCI projects in DoD laboratories and report the scientific progress and impacts. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2018 to FY 2019 increase supports the addition of two new Vannevar Bush Fellows.			
Accomplishments/Planned Programs Subtotals	22.220	28.168	29.617

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 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z / *National Defense Education Program (NDEP)*

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	-	76.995	74.298	85.919	-	85.919	92.338	99.447	108.152	111.307	Continuing	Continuing
120: *National Defense Education Program (NDEP)*	-	76.995	74.298	85.919	-	85.919	92.338	99.447	108.152	111.307	Continuing	Continuing

A. Mission Description and Budget Item Justification

The National Defense Education Program (NDEP) fosters and enhances the Department of Defense's (DoD) ability to access high-quality science, technology, engineering, and mathematics (STEM) personnel vital to national defense now and in the future. NDEP is executed by the STEM Development Office, under the Defense Laboratories Office within the Office of the Under Secretary of Defense for Research and Engineering (USD(R&E)). NDEP's portfolio includes the Science, Mathematics, and Research for Transformation (SMART) program, the Military Child Pilot Program (MCPP), STEM Education and Outreach, and the Manufacturing Engineering Education Program (MEEP). These programs provide a pathway to the best and the brightest minds through a continuum of DoD workforce development approaches, which include: (1) increasing STEM proficiency in the Nation by enabling an increased capacity to address ever-changing future defense workforce needs; (2) shaping the Department as a STEM workplace of choice for scientists and engineers through programs and outreach; (3) leading the Departmental STEM strategic efforts and coordinating STEM efforts in alignment with the workforce and mission requirements; and (4) identifying approaches for innovative solutions in support of the Nation's current and future defense challenges.

NDEP aligns to the DoD Science and Technology (S&T) priorities. It is synchronized with the Federal Five-Year STEM Education Strategic Plan, the DoD STEM Strategic Plan, the DoD Strategic Workforce Plan, and the DoD Agency Strategic Plan. NDEP components engage in assessment and evaluation as outlined by the Office of Management and Budget and the Government Accountability Office.

The SMART program awards highly competitive scholarships-for-service to undergraduate and graduate students in 19 STEM academic disciplines and hires the students, upon graduation, into DoD's workforce. As part of the SMART experience, scholars engage in internships that allow for relevant hands-on research and work experiences in DoD facilities, thereby enhancing their educational experience. Since its inception as a pilot program in FY 2005, SMART has awarded approximately 2,400 scholarships to students ranging from undergraduate to doctoral studies. To date, approximately 1,350 have completed their academic pursuit and transitioned into DoD employment. Approximately 1,100 have completed their service to the Department. SMART ensures the Department has a steady infusion of high-quality technical talent, prepared in areas of critical importance to DoD, and ready to apply their technical knowledge, skills, and abilities to fulfill DoD's mission.

The MCPP enhances the preparation of dependents of members of the armed forces for careers in STEM and provides assistance to STEM teachers at elementary or secondary schools at which a significant number of military dependents are enrolled. Section 233 of the National Defense Authorization Act (NDAA) for FY 2015, and the Consolidated and Further Continuing Appropriations Act, 2015, authorized the establishment of this Pilot Program.

STEM Education and Outreach fosters conditions for activities to support and cultivate STEM talent with minds for innovation, diversity of thought, and the technical agility to sustain the Department's competitive edge. In order to build a necessary workforce that brings in an expansion of ideas to solve national defense needs and challenges, the DoD recognizes the need for increased participation of underserved groups in STEM activities and education programs. Initiatives include investing,

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z / *National Defense Education Program (NDEP)*	

promoting, and participating in national-level STEM programs and efforts as well as providing authentic hands-on STEM experiences for students and teachers across the Nation.

The DoD is constantly looking for innovative scientific and technological solutions to address current and future military requirements. The MEEP will enhance existing or establish new education programs that support manufacturing engineering.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	69.345	74.298	80.489	-	80.489
Current President's Budget	76.995	74.298	85.919	-	85.919
Total Adjustments	7.650	0.000	5.430	-	5.430
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.253	-			
• FFRDC Transfer	-0.087	-	-	-	-
• Other Program Adjustments	-0.010	-	5.967	-	5.967
• Economic Assumption	-	-	-0.537	-	-0.537

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 120: *National Defense Education Program (NDEP)*		
Congressional Add: *Manufacturing Engineering Education Program (MEEP)*	10.000	-
Congressional Add Subtotals for Project: 120	10.000	-
Congressional Add Totals for all Projects	10.000	-

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Science, Mathematics, and Research for Transformation (SMART) Defense Education Program	52.439	60.747	72.041

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z / *National Defense Education Program (NDEP)*

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

Description: SMART is a scholarship-for-service program that provides support to high performing U.S. graduate and undergraduate students in 19 academic science, technology, engineering, and mathematics (STEM) disciplines identified as areas of future workforce needed by DoD.

The disciplines align with the Department's Science and Technology (S&T) priorities and emerging scientific research areas, and include: Aeronautical and Astronautical Engineering; Biosciences; Chemical Engineering; Chemistry; Civil Engineering; Cognitive, Neural, and Behavioral Sciences; Computer Science; Electrical Engineering; Geosciences; Industrial and Systems Engineering; Information Sciences; Materials Science and Engineering; Mathematics; Mechanical Engineering; Naval Architecture and Ocean Engineering; Nuclear Engineering; Oceanography; Operations Research; and Physics. Upon completion of their degree, students fulfill a service commitment to the Department on a one-to-one payback per year of education funded. In part, SMART's success is measured by participants that choose to remain in the DoD workforce beyond their required service commitment. Approximately 1,100 participants have successfully completed the program through their DoD Service commitment, of which 74 percent of those participants are still employed by DoD.

Oversight of the SMART program falls under the Office of the Under Secretary of Defense for Research and Engineering (USD(R&E)). Two types of individuals participate in the program: (1) retention scholars who are current DoD employees; and (2) recruitment scholars who are college students enrolled in undergraduate and graduate programs and represent new talent for the Department. Internships provide SMART scholars with an opportunity to engage in relevant hands-on research and work experiences in defense laboratories, thereby enhancing their educational experience.

Since FY 2005, approximately 2,400 students have participated in the SMART program at approximately 160 sponsoring facilities. As of August 2016, approximately 1,350 SMART scholars have transitioned into the service commitment phase. To date, these scholars have transitioned as civilian employees into the Air Force, Army, Navy, and other DoD components.

FY 2018 Plans:
• Increase new SMART awards by 10% to better meet the growing needs of the DoD STEM workforce, allowing us to meet approximately 50% of Components requirements.
• Enhance current recruitment efforts to include more information sessions allowing the Department to better meet the increasing needs of the DoD STEM workforce.
• Conduct a SMART Symposium to continually enhance inter-service collaboration.
• Implement debt collection procedures.
• Assess SMART scholar inception process into DoD facilities and laboratories.

FY 2019 Plans:

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z / *National Defense Education Program (NDEP)*

C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
• Increase new SMART awards by 10% to better meet the growing need of the DoD STEM workforce, allowing us to meet approximately 55% of Components requirements. • Nine percent increase in total SMART awards focusing on disciplines supporting the advancement of Artificial Intelligence, Microelectronics, and Hypersonics within the DoD. • Implement a robust recruitment effort to ensure the Department continues to meet the increasing needs of the DoD STEM workforce. • Conduct a SMART Symposium to continually enhance inter-service collaboration. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in the FY 2018 to FY 2019 budget will support a 10% increase in new SMART awards.			
Title: Pilot Program to Enhance the Preparation of Dependents of Members of the Armed Forces for Careers in STEM (Military Child Pilot Program) ***Description:*** The Military Child Pilot Program was formally established by the FY 2015 National Defense Authorization Act (NDAA), Section 233, and the Consolidated and Further Continuing Appropriations Act, 2015. The objectives of the program are to enhance the preparation of dependents of members of the armed forces for careers in STEM and to provide assistance to STEM teachers at elementary or secondary schools at which a significant number of military dependents are enrolled. Currently, the Department's methodology includes: (1) providing support to the National Math and Science Initiative (NMSI) College Readiness Program (CRP) in collaboration with the DoD Education Activity (DoDEA) to expand the number of covered schools and support the national goal; and (2) coordinating with the DoD components, federal and local government partners, and private sector organizations to complement the NMSI program. School implementation occurs over a three-year period and all implementation costs are budgeted in the fiscal year in which implementation occurs. ***FY 2018 Plans:*** • Provide STEM educational and training opportunities for students and teachers at covered schools. • Complete implementation of NMSI program at 40 covered schools in academic year 2017-2018. • Reach a minimum of 10 new covered schools in academic year 2018-2019. • Implement and assess the Department-wide pilot program in coordination with the DoD components, federal and local government partners, and private sector organizations. ***FY 2019 Plans:*** • Provide STEM educational and training opportunities for students and teachers at covered schools. • Implement and assess the Department-wide pilot program in coordination with the DoD components, federal and local government partners, and private sector organizations.	11.112	8.889	8.889
Title: STEM Education and Outreach	3.444	4.662	4.989

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z / *National Defense Education Program (NDEP)*

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

Description: STEM Education and Outreach fosters conditions for activities to support and cultivate STEM talent with minds for innovation, diversity of thought, and the technical agility to sustain the Department's competitive edge. In order to build a necessary workforce that brings in an expansion of ideas to solve national defense needs and challenges, the DoD recognizes the need for increased participation of underserved groups in STEM activities and education programs. Investments are made to promote participation in national-level STEM programs and initiatives and provide authentic hands-on experiences for students and teachers across the globe. Specific initiatives include internships, scholarships, and mentorships through partnerships with industry to include FIRST Robotics, MATCHCOUNTS, and the Center for Excellence in Education's (CEE) "Rickover" and Research Science Institute (RSI) programs. To supplement the MCPP, the Department has partnered with the Society for Science and the Public (SSP) to provide science resources to military-connected high schools. In addition, STEM Education and Outreach manages activities, in support of the Department's STEM Strategic Plan, to assist in attracting, inspiring, and developing exceptional STEM talent across the education continuum. STEM Education and Outreach develops and maintains systems and standards to support its programs, implementing the Communications Plan and collaborating across the Federal government and public domain through interagency and intra-departmental working groups and partnerships.

FY 2018 Plans:
• Continue STEM Education and Outreach activities that provide authentic hands-on experiences to students and teachers and evaluate the effectiveness of the increased outreach, for example, FIRST Robotics, MATHCOUNTS and CEE/RSI programs.
• Implement SSP resources at military-connected high schools to provide access to real-world science examples and information.
• Participate in inter- and intra-departmental collaboration with program partners to achieve federal and DoD STEM objectives.
• Develop and implement a joint framework to increase access to STEM program-level outcome data for oversight and evaluation of DoD-wide STEM programs and investments.
• Formalize consistent assessment and evaluation metrics that are appropriate for specific types of programs and audiences.

FY 2019 Plans:
• Continue STEM Education and Outreach activities that provide authentic hands-on experiences to students and teachers and evaluate the effectiveness of the increased outreach, for example, FIRST Robotics, MATHCOUNTS and CEE/RSI programs.
• Expand SSP resources at military-connected high schools to provide access to real-world science examples and information.
• Participate in inter- and intra-departmental collaboration with program partners to achieve federal and DoD STEM objectives.
• Update the Department's STEM Strategic Plan.
• Implement joint framework to increase access to STEM program-level outcome data for oversight and evaluation of DoD-wide STEM programs and investments, making evidence-based adjustments and improvements.

FY 2018 to FY 2019 Increase/Decrease Statement:

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The increase in budget from FY 2018 to FY 2019 will support an evaluation of STEM Education and Outreach programs.			
Accomplishments/Planned Programs Subtotals	66.995	74.298	85.919

	FY 2017	FY 2018
Congressional Add: Manufacturing Engineering Education Program (MEEP)	10.000	-
FY 2017 Accomplishments: • Collaborated with the Manufacturing & Industrial Base Policy (MIBP) office to build and execute a portion of the Manufacturing Engineering Education Program (MEEP) through a solicitation through multiple Manufacturing Institute for consortium proposals. • Coordinating Broad Agency Announcement (BAA) opportunities to competitively solicit proposals relative to the MEEP Program that will provide funding support to higher education institutes, non-profits and industry in support of MEEP.		
Congressional Adds Subtotals	10.000	-

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

F. Performance Metrics

Current metrics are subject to ongoing evaluation and analysis of appropriateness and effectiveness of the metrics being performed.

• The increase in the number of SMART scholars who are transitioned into the DoD workforce.
- In FY 2017, 107 Scholars were hired by the Department.
• The number of SMART scholars who are retained by DoD post-service commitment.
- Since 2006, 766 participants have been retained post service commitment, a 74% rate for the program.
• Participation by underserved populations; and where applicable course completions and credentials received.
SMART FY 2017
- Gender:
F: 34%
M: 65%
Do not wish to be identified: 1%

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* I BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601120D8Z I *National Defense Education Program (NDEP)*

- Ethnicity:
Not Hispanic: 85%
Hispanic: 4%
Do not wish to be identified: 11%
- Race
American Indian or Alaska Native: 3%
Asian: 10%
Black: 13%
- Native Hawaiian or Other Pacific Islander: 1%
- White: 66%
- Do not wish to be identified: 7%
• The number of SMART application reviewers from HBCU/MIs.
- There are currently 19 reviewers from HBCU/MIs.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601228D8Z / *Historically Black Colleges and Universities and Minority-Serving Institutions*

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	-	32.709	25.865	30.412	-	30.412	30.796	31.356	31.893	32.497	Continuing	Continuing
448: *Historically Black Colleges and Universities and Minority-Serving Institutions*	-	32.709	25.865	30.412	-	30.412	30.796	31.356	31.893	32.497	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element (PE) provides support for Historically Black Colleges and Universities and Minority-Serving Institutions (HBCU/MI) program in fields of science and engineering that are important to national defense. The Department of Defense (DoD) HBCU/MI program encourages participation of small minority schools as well as large minority research institutions. The program is authorized by 10 U.S.C. § 2362 and is funded by annual appropriations. This competitive program provides support through grants, cooperative agreements, or contracts for research, education assistance, and instrumentation purchases.

Work in this PE provides a foundation to enhance participation of HBCUs/MIs in DoD research, including infrastructure; strengthen research and educational opportunities at HBCUs/MIs and increase the number of minority graduates in the science, technology, engineering, and mathematics (STEM) disciplines important to the national defense; and build a more diverse pool of scientists and engineers to meet future workforce needs.

Work in this PE is performed by the Services' Research Offices and DoD Laboratories (includes the Army Research Laboratory and the Air Force Research Laboratory) for Centers of Excellence (COE). Centers currently funded through cooperative agreements include COEs in Autonomy, Cyber Security, and Research Data Analysis.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	23.572	25.865	30.626	-	30.626
Current President's Budget	32.709	25.865	30.412	-	30.412
Total Adjustments	9.137	0.000	-0.214	-	-0.214
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.860	-			
• Other Program Adjustments	-0.003	-	-0.010	-	-0.010
• Economic Assumption	-	-	-0.204	-	-0.204

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601228D8Z / *Historically Black Colleges and Universities and Minority-Serving Institutions*

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2017**	**FY 2018**
Project: 448: *Historically Black Colleges and Universities and Minority-Serving Institutions*		
Congressional Add: *HBCU/MI Program Increase*	10.000	-
Congressional Add Subtotals for Project: 448	10.000	-
Congressional Add Totals for all Projects	10.000	-

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601228D8Z / *Historically Black Colleges and Universities and Minority-Serving Institutions*	**Project (Number/Name)** 448 / *Historically Black Colleges and Universities and Minority-Serving Institutions*

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
448: *Historically Black Colleges and Universities and Minority-Serving Institutions*	-	32.709	25.865	30.412	-	30.412	30.796	31.356	31.893	32.497	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Historically Black Colleges and Universities and Minority-Serving Institutions (HBCU/MI) program provides support in fields of science and engineering that are important to national defense. The Department of Defense (DoD) HBCU/MI Program encourages participation of small minority schools and large minority research institutions. This competitive program provides support through grants or contracts for research, education assistance, instrumentation purchases, and technical assistance as described below.

• Research. The research grants are to further the knowledge in the basic scientific disciplines through theoretical and experimental activities. Collaborative research allows university professors to work directly with military laboratories or other universities.

• Education. Education assistance funds are used by minority institutions to strengthen their academic programs in science, technology, engineering, and mathematics (STEM), thereby increasing the number of under-represented minorities obtaining undergraduate and graduate degrees in these fields. These grants provide equipment, scholarships, cooperative work/study opportunities, visiting faculty programs, summer internship programs, and a variety of other enhancements designed to support students and to encourage them to pursue careers in STEM.

• Instrumentation purchases. The program allows universities to purchase basic laboratory equipment, such as lasers and spectrometers, for enhancements to the basic research efforts.

• Technical assistance. The funds are used to design programs that enhance the ability of minority institutions to successfully compete for future Defense funding by assisting the HBCU/MI community in areas such as proposal writing and administration of grants and contracts.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Historically Black Colleges and Universities and Minority-Serving Institutions (HBCU/MI) ***Description:*** The HBCU/MI program provides support for research and collaboration with DoD facilities and personnel. The research grants further knowledge in the basic physical scientific and engineering disciplines through theoretical and empirical activities. Collaborative research allows university professors to work directly with DoD laboratories or other universities. ***FY 2018 Plans:***	22.709	25.865	30.412

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601228D8Z / *Historically Black Colleges and Universities and Minority-Serving Institutions*	**Project (Number/Name)** 448 / *Historically Black Colleges and Universities and Minority-Serving Institutions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Continue efforts from FY 2017. Conduct annual competition of the HBCU/MI program for basic research, student support, and/or equipment/instrumentation. Continue the research and educational collaboration with the Thurgood Marshall College Fund (TMCF) Project, a non-profit organization that assists in the selection of HBCU/MI students and faculty for scholarships, internships, and research in pursuit of science, technology, engineering, and mathematics (STEM) careers. Work towards the goal of increasing the number of FY 2018 summer interns and faculty research fellows from 85 to 100 participants. Monitor established Centers of Excellence in support of the Under Secretary of Defense for Research and Engineering (USD(R&E)) Science and Technology priorities in the areas of Cyber Security, Research Data Analysis, Autonomy, and the newly established FY 2017 Center for STEM Scholars, in response to H.R. 114-139 (accompanying H.R. 2685, the FY 2016 DoD appropriations act) using the FY 2017 DoD HBCU/MI congressional program increase, which required DoD to expand STEM opportunities for underrepresented minorities. Conduct annual review of the Centers. Host outreach activities that will include one webinar and two technical assistance workshops to expose HBCUs/MIs to opportunities in DoD. ***FY 2019 Plans:*** Continue efforts from FY 2018. Conduct annual competition of the HBCU/MI program for basic research, student support, and/or equipment/instrumentation. Continue the research and educational collaboration with the TMCF. Plan to increase the number of FY 2018 summer interns and faculty research fellows from 100 to 110 participants. Monitor established Centers of Excellence in support of the USD(R&E) Science and Technology priorities in the areas of Cyber Security, Research Data Analysis, Autonomy, and the Center for STEM Scholars, needed to expand STEM opportunities for underrepresented minorities. Conduct annual review of the Centers. Host outreach activities, to include one webinar and two technical assistance workshops to expose HBCUs/MIs to opportunities in DoD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in budget from FY 2018 to FY 2019 will support ten additional student interns.			
Accomplishments/Planned Programs Subtotals	22.709	25.865	30.412

	FY 2017	FY 2018
Congressional Add: HBCU/MI Program Increase	10.000	-
FY 2017 Accomplishments: Developed a funding opportunity announcement for the establishment of a HBCU/MI Center of Excellence for STEM Scholars (modeled on the Hopps Scholars program and in furtherance of H.R. 114-139, accompanying H.R. 2685, FY 2016 DoD appropriations act, requiring DoD to address plans to expand STEM opportunities for underrepresented minorities). Graduates are expected to pursue studies and research careers, including at DoD.		

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601228D8Z / *Historically Black Colleges and Universities and Minority-Serving Institutions*	**Project (Number/Name)** 448 / *Historically Black Colleges and Universities and Minority-Serving Institutions*

	FY 2017	**FY 2018**
Facilitated HBCU/MI student involvement in STEM areas and possible research careers within the Department by placing 81 interns and 15 faculty fellows at DoD laboratories in summer 2017. The interns/fellows gave presentations about their research experiences at an August 2017 Basic Research Office-sponsored event. Worked with Air Force Research Laboratory (AFRL) in Rome, New York to provide summer 2017 research opportunities for students from HBCUs/MIs operating the Centers of Excellence for Autonomy, Cyber Security, and Research Data Analysis. The results of these students' summer research experiences were presented at a poster session at AFRL in August 2017. Coordinated with the Navy Cyber Security Information Assurance Program Partnership to provide four internship/co-op opportunities for HBCU/MI students in information assurance/cyber security.		
Congressional Adds Subtotals	10.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

- Number of students funded other than undergraduates
- Number of undergraduate students funded
- Number of undergraduates funded who graduated
- Number of students participating in the Centers of Excellence for Research and Education
- Number of students working in Defense Laboratories
- Number of undergraduates funded who graduated with degrees in STEM
- Number of graduates who will continue to pursue graduate or Ph.D. degrees in STEM
- Number of graduates who intend to work for DoD
- Number of undergraduates who will receive scholarships and fellowships for further studies in STEM

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint 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	95.176	17.611	19.111	19.170	-	19.170	19.361	19.648	19.994	20.372	Continuing	Continuing
000: *Insensitive Munitions*	65.795	11.898	19.111	12.972	-	12.972	13.106	13.289	13.540	13.803	Continuing	Continuing
204: *Enabling Fuze Technology*	29.381	5.713	0.000	6.198	-	6.198	6.255	6.359	6.454	6.569	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

This program addresses applied research associated with improving the lethality, reliability, safety, and survivability of munitions and weapon systems. The goal is to develop joint enabling technologies that can be used by the Program Executive Officers (PEOs) as they develop their specific weapon programs. The program invests in research of technologies from a Joint Service perspective, thus maximizing efficiencies, ensuring the development of technology with the broadest applicability while avoiding duplication of efforts.

Munition Area Technology Groups (MATGs) and Fuze Area Technology Groups (FATGs) have been established for each munition and capability area and are tasked with: 1) coordinating, establishing, and maintaining 2018 and 2023 year technology development plans and roadmaps, 2) coordinating biannual meetings to review technical and programmatic details of each funded and proposed effort, 3) developing and submitting Technology Transition Agreements in coordination with appropriate PEOs for insertion in their Insensitive Munitions (IM) Strategic Plans / Fuze Technology Development Plan, and 4) interfacing with other MATGs / FATGs and IM / fuze science and technology projects as appropriate. The Joint Insensitive Munitions Technology Program (JIMTP) and Joint Fuze Technology Program (JFTP) will utilize a Technical Advisory Committee (TAC) (consisting of senior Department of Defense (DoD) and Department of Energy (DOE) laboratory representatives, and senior Munitions PEO representatives) to provide program oversight, policy, direction, and priorities during its annual meeting.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	17.745	19.111	19.307	-	19.307
Current President's Budget	17.611	19.111	19.170	-	19.170
Total Adjustments	-0.134	0.000	-0.137	-	-0.137
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.111	-			
• Other Program Adjustments	-0.003	-	-0.008	-	-0.008

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*

• FFRDC Transfer	-0.020	-	-	-	-
• Economic Assumption	-	-	-0.129	-	-0.129

Change Summary Explanation

FY 2019 adjustments are reflective of minor budget adjustments.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 000 / *Insensitive Munitions*

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
000: *Insensitive Munitions*	65.795	11.898	19.111	12.972	-	12.972	13.106	13.289	13.540	13.803	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Joint Insensitive Munitions (IM) Technology Program (JIMTP) aims to develop the enabling technologies needed to build weapons in compliance with statutory requirements (United States Code, Title 10, Chapter 141, Section 2389) and regulation (DoDI 5000.1 and 5000.02, and CJCSI 3170.01F). This effort will take promising technologies developed at the laboratory scale and mature them for transition into advanced technology (Budget Activity (BA) 6.3) programs based on the priority munitions identified in the DoD IM Strategic Plans. Mature and demonstrated IM technology can be transitioned to the Program Executive Officers (PEOs), thereby decreasing the program costs and schedule risk. This will additionally promote spin-offs to other non-compliant munitions within the DoD portfolio. Without new technology, future variants of current weapon systems will have the same, or worse, response to IM stimuli. New weapon developments will face similar challenges. This is especially true with increased performance requirements for improved and new systems.

The JIMTP investments focus on five Munition Areas: 1) High Performance Rocket Propulsion, 2) Minimum Signature Rocket Propulsion, 3) Blast and Fragmentation Warheads, 4) Anti-Armor Warheads, and 5) Gun Propulsion. Munition Area Technology Groups (MATGs), under tri-service leadership, have developed technology roadmaps for each Munition Area that are used to guide investments based on goals consistent with the DoD IM Strategic Plans. The program is structured around these five areas with clear cross-cutting tasks.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High Performance Rocket Propulsion (HPP) ***Description:*** HPP focuses on the development of technologies to improve the IM response of HPP systems, rocket motors with Ammonium Perchlorate and with or without a metal fuel, for rockets and missiles launched from air, ground, and sea platforms. These technologies, when applied to rocket motors, improve to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, rocket propellant ingredients, including synthesis, characterization, and scale-up; reduced smoke or smoky propellants, including formulation, characterization and scale-up; rocket motor case design; materials for active and passive thermal mitigation; shock mitigation materials and techniques; passive and active coatings; active and passive venting techniques for motor cases or containers; ignition systems; sensors; and thrust mitigation techniques. Operating conditions may be controlled or widely varying in both temperature and vibration. The 2023 and 2028 year goals of the HPP MATG are concentrated on solving the IM response of missile propulsion systems due to Fragment Impacts and Slow Cook Off for the majority of HPP rocket motors, and solving the Fast Cook Off response of very large HPP motors. ***FY 2018 Plans:*** - Determine the IM response of missile propulsion systems due to Fragment Impacts and Slow Cook Off using small scale testing. - Examine the Fast Cook Off response of very large HPP motor formulation with modified properties.	3.254	9.738	3.472

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 000 / *Insensitive Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Complete pint scale propellant formulation and scale up to one gallon mixes. - Begin work on novel rocket motor case assembly with ability to reduce fast and slow cookoff reactions, as well as fragment and bullet impact responses. - Conduct thermal testing of heat suppression materials for fast and slow cookoff protection of shipboard munitions and develop sub-scale tests to determine coating ability of materials. ***FY 2019 Plans:*** - Complete thermal and aging study on propellant formulation; conduct mini-scale rocket motor testing and sub-scale fragment impact testing to determine propellant response. - Conduct mechanical properties and test various designs for novel rocket motor case, and complete down-selection of materials. - Conduct scaled-up testing of thermal suppression material to determine optimal placement of system within shipboard container. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Minimum Signature Rocket Propulsion (MSP) ***Description:*** MSP focuses on the development and demonstration of technologies to improve the IM response of MSP systems. The development and demonstration of minimum signature (MS) rocket technologies, when applied to munition systems, will improve munition IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, MS rocket propellant formulations, ingredients for MS propellant formulations (including synthesis, characterization and scale-up), case and packaging design, active and passive venting techniques, rocket motor case design, ignition systems, and thrust mitigation techniques. Of particular interest are technologies that provide a higher burning rate minimum signature propellant with state-of-the-art energy and reduced shock sensitivity. The 2023 and 2028 year goals of the MSP MATG are concentrated on solving the IM response of missile propulsion systems due to Fragment Impact, Slow Cook Off, and Shaped Charge Jet (SCJ) threats. ***FY 2018 Plans:*** - Determine the IM response of missile propulsion systems due to Fragment Impact, Slow Cook Off, and SCJ threats. - Prepare preliminary propellant formulations, conduct sensitivity testing, downselect to best candidate materials, and scale up to one gallon mixes. - Prepare environmentally safe propellant formulations and downselect to best formulation, after conducting standard small scale tests. - Scale up from pint to gallon mixes of novel propellant and conduct sensitivity testing to mini-fragment test.	2.254	2.442	2.442

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 000 / *Insensitive Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Synthesize 100 gram quantities of three precursor materials to formulate a reduced shock sensitive propellant formulation and conduct baseline tests. - Modify high sensitivity propellant formulations to obtain desired properties, scale up to pint mixes to conduct testing, and verify processing characteristics. ***FY 2019 Plans:*** - Scale up downslected propellant formulation from one to five gallon mixes, and conduct sub-scale rocket motor firing. - Scale up 100 gram quantities to 20 pound samples, conduct mechanical properties and sensitivity testing, to downselect to best candidate material. - Downselect modified high sensitivity formulations to six candidates to compare against baseline propellant, and conduct performance as well as fragment insult testing. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Blast and Fragmentation Warheads (BFW) ***Description:*** BFW focuses on the development of technologies to improve the IM response of Blast/Fragmentation munitions. These technologies, when applied to munitions, improve IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintain munition performance. Munition operating conditions may be controlled or have widely varying environmental conditions, such as temperature and vibration, and other factors such as cost, availability and reliability may be critically important depending on the intended munition application. Technologies include, but are not limited to, new ingredient synthesis and characterization, initial formulation development, scale-up, warhead/charge configuration, venting techniques for both munitions and their containers, protection or packaging materials and systems, shock mitigation liners, initiation devices, techniques, and technologies. Applications vary but include high performance warhead fills, booster explosives, bulk demolition charges, and bulk fills for blast and/or fragmentation charges. The 2023 and 2028 year goals of the BFW MATG are concentrated on solving the IM response of blast fragment warheads to the Sympathetic Detonation, Fragment Impact, and SCJ threats. ***FY 2018 Plans:*** - Determine the IM response of blast fragment warheads to the Sympathetic Detonation, Fragment Impact, and SCJ threats. - Produce 25 pounds of energetic material to serve as baseline for comparison testing against new energetic material produced using a novel method. Produce 10 pounds of the material and conduct sensitivity testing and mechanical properties tests. - Conduct small scale testing on insensitive explosive materials to validate new testing procedure. - Use modeling to further understand explosive reformulation efforts and warhead liner optimization results, and prepare for prepare for small-scale environmental testing.	2.415	2.601	2.728

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602000D8Z / *Joint Munitions Technology*	Project (Number/Name) 000 / *Insensitive Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Synthesize novel explosive materials to mitigate sympathetic reaction of cast cured munitions; conduct mechanical property testing on new materials. - Conduct modeling and simulation to better understand the current booster material performance in sympathetic reaction, in order to tailor new booster material formulations. ***FY 2019 Plans:*** - Use novel energetic material to complete performance and larger scale sensitivity tests. - Conduct small-scale environmental testing on explosive reformulations to downselect and pair with the optimized warhead liner. - Conduct larger scale testing on selected formulations and prepare for sub-scale sympathetic reaction testing. - Scale up synthesis of novel energetic, conduct hazard and testing and characterization, and small scale sensitivity testing to prepare for pilot scale-up and testing. - Optimize new booster material formulations, fabricate hardware to conduct testing, and down-select to best performing material to prepare to integrated testing with new explosive material under development. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding will be used for the 1000 pound general purpose bomb formulation work to improve performance and decrease sensitivity over currently available explosive fills.			
Title: Anti-Armor Warheads (AAW) ***Description:*** AAW focuses on the development of explosive ingredients, explosives, and warhead and fuze technologies for improving IM of AAW munitions. The development of explosive ingredients, explosives, and warhead and fuze technologies, when applied to munitions, improve IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintain munition performance. Technologies include, but are not limited to, new ingredient synthesis and characterization, initial formulation development, scale-up, warhead/charge configuration, venting techniques for both munitions and their containers, protection/packaging materials and systems, shock mitigation liners, and initiation devices, techniques, and technologies. Applications vary but include high performance warhead fills, booster explosives, and all other technology to mitigate the violent response of AAW munitions to IM threats. Munition operating conditions may be controlled or have widely varying environmental conditions, such as temperature and vibration, and other factors such as cost, availability, and reliability may be critically important depending on the intended munition application. The 2023 and 2028 year goals of the AAW MATGs are concentrated on solving the IM response of anti-armor warheads to the Fragment Impact and Slow Cook-off, threats for larger and Medium Caliber Munitions. ***FY 2018 Plans:***	2.185	2.371	2.371

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 000 / *Insensitive Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Solve the IM response of anti-armor warheads to the Fragment Impact, Sympathetic Reaction, and Shaped Charge Jet threats for larger munitions and the Fragment Impact, Slow Cook-off, and Sympathetic Reaction / Shaped Charge Jet threats for Medium Caliber Munitions. ***FY 2019 Plans:*** - Work on solutions to improve the IM response of anti-armor warheads to the Fragment Impact, Sympathetic Reaction, and Shaped Charge Jet threats for larger munitions and the Fragment Impact, Slow Cook-off, and Sympathetic Reaction / Shaped Charge Jet threats for Medium Caliber Munitions. - Complete design of experiments on pressed explosive formulation for multi-use material, scale-up material formulations, and start to conduct characterization studies. - Down-select nano explosive composites for medium caliber ammunition, conduct pressing study, and begin scale-up production of composite material to kilogram batches. - Produce precursor materials for new novel explosive material and produce 10 kg of new material, then conduct studies to ensure viability and optimize material. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Gun Propulsion (GP) ***Description:*** GP focuses on the development and demonstration of technologies in the area of GP systems. The development and demonstration of gun propulsion technologies, when applied to munition systems, will improve munition IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, gun propellant formulations, ingredients for gun propellant formulations, including synthesis, characterization and scale-up, cartridge case and packaging design, active and passive venting techniques, reduced sensitivity primer propellant and primer systems, and robust primers for insensitive propellants. Applications vary, but include both large and medium caliber munitions, as well as propelling charges for mortars and shoulder launched munitions. Operating requirements vary, and other factors such as barrel life and operation over varying environmental conditions may be critically important depending on the intended munition application. The 2023 and 2028 year goals of the GP MATG are concentrated on solving the IM response of gun propulsion munitions to Fragment Impact and Slow and Fast Cook Off threats. ***FY 2018 Plans:*** - Develop solutions to improve the IM response of gun propulsion munitions to Fragment Impact and Slow Cook Off threats. - Develop small scale process using novel materials to produce improved cartridge case for larger gun propulsion system and begin aging study on materials.	1.790	1.959	1.959

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 000 / *Insensitive Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Scale up to 2.5 kilogram batches the down-selected new large caliber propellant formulation, begin stability, mechanical properties, and prepare for small scale cookoff and fragment testing. - Development of small scale test for gun propellant bed characterization for fragment impact testing. ***FY 2019 Plans:*** - Fabricate improved cartridge cases for larger gun propulsion system, down-select prototypes after fast cookoff and fragment impact tests to complete loaded cartridges in a Budget Activity 3 project. - Complete small scale cookoff and fragment testing for new large caliber propellant formulation and scale-up to 10 kilogram batches to prepare for large scale cookoff and fragment impact testing. - Conduct intermediate scale fragment testing on gun propellant grains to verify results against expectations for testing new propellants in small scale samples. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Accomplishments/Planned Programs Subtotals	11.898	19.111	12.972

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• 0603000D8Z P002: *BA 3 Insensitive Munitions Advanced Technology*	17.738	19.039	19.138	-	19.138	19.356	19.636	19.970	20.392	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

1) Transition of technologies developed by the Program are tracked and documented by technology maturity.
2) Munition Area Technology Group (MATG) Technology Roadmaps are prepared, evaluated, and analyzed by Joint Insensitive Munitions Technology Program management and technical staff.
3) Chairman's Annual Assessments for each MATG are critically reviewed by the Technical Advisory Committee to determine progress, transition plans, and relevance of each project.
4) Project progress toward goals and milestones is assessed at each MATG meeting.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
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5) Annual technical reports and papers are tracked and documented for the Program.
6) External peer review of projects conducted as part of Joint Army/Navy/NASA/Air Force meetings.

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 204 / *Enabling Fuze 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
204: *Enabling Fuze Technology*	29.381	5.713	0.000	6.198	-	6.198	6.255	6.359	6.454	6.569	Continuing	Continuing

A. Mission Description and Budget Item Justification

This RDT&E effort will demonstrate fuze enabling technologies needed to develop weapons that address priority capability areas identified in the Guidance for Development of the Force (GDF), the Secretary of Defense Memorandum, "DoD Policy on Cluster Munitions and Unintended Harm to Civilians," and shortfalls in current weapon systems. This effort will develop enabling technologies at the laboratory scale and transition them into Budget Activity (BA) 6.3 demonstration programs for weapons where priority capabilities and technology needs have been identified and validated by the Program Executive Officers (PEOs) and the Heads of the Service Science and Technology (S&T) communities. Mature BA 6.2 fuze technologies will be transitioned, thereby decreasing their program costs and schedule risk and facilitating spin-offs to other munitions within their portfolios.

The Joint Fuze Technology Program (JFTP) investments are focused on capability areas that have been validated by the PEOs and Heads of the Service S&T communities. The four capability areas are: 1) Hard Target Survivable Fuzing, 2) Tailorable Effects (TE) Weapon Fuzing, 3) High Reliability Fuzing, and 4) Enabling Fuze Technologies and Common Architecture.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Hard Target Fuzing ***Description:*** The Hard Target Fuzing challenges are grouped into three technology areas. First, improved modeling and simulation (M&S) capabilities provide the validated computational tools necessary for hard target applications. Second, basic phenomenology and understanding of the fuze environment is the science-based endeavor of providing the test equipment, instrumentation, and analysis techniques for experimentation and data gathering necessary for next generation fuzing. Third, hard target survivable fuze components are developed to increase the effectiveness of facility denial munitions by improving the prediction tools and testing methodologies to evaluate the survivability and functionality of legacy and future fuzes. Development of these technologies will enable next generation boosted and hypersonic penetrators to execute missions against hardened and deeply buried targets. ***FY 2018 Plans:*** - Demonstrate modeling and simulation tool for predicting the dynamic response of hard target embedded fuze systems for shock environments. - Complete demonstration of a low cost multi-G level fuze sensor suite that will discern penetration of concrete, sand/soil, and voids. ***FY 2019 Plans:***	1.465	0.000	1.552

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 204 / *Enabling Fuze Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Complete and release modeling and simulation tools to Service weapon designers that improve the prediction of the dynamic response of embedded fuze systems for High G shock environments. - Conduct High G characterization testing for establishing design guidelines of ruggedizing fuzes in high shock environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Tailorable Effects Fuzing ***Description:*** Develop fuzing for tailorable effects weapons that encompasses the ability to selectively vary the output of the weapon (Dial-a-Yield) and/or the ability to generate selectable effects (e.g., directed blast, fragmentation). Develop initiation and multi-point technologies; electronic safe and arm based multi-point initiators for tunable output – scalable yield warheads; MicroElectro-Mechanical Systems (MEMS) based multi-point initiators for tunable output/scalable yield warheads; and smart fuzing for tailorable effects weapons. These technologies will enable weapons that can effectively defeat a variety of targets while minimizing unintentional collateral effects. ***FY 2018 Plans:*** - Demonstrate wirelessly powering and functioning distributed detonating output technology in a multi-output safe, arm, and fire system. - Demonstrate fuze micro-detonator for application in medium caliber and area effects weapons that provides 20% increase in performance and 30% decrease in size over current technology. ***FY 2019 Plans:*** - Demonstrate government owned detonator formulation for in-line electronic safe arm device (ESAD) used in conventional and High G weapon applications. - Develop fuze critical component technologies for in-line ESADs such as high voltage switches that provide alternatives to current single point solutions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.	1.303	0.000	1.415
Title: High Reliability Fuzing ***Description:*** Develop high reliability fuzing architectures, fuzing components, and Unexploded Ordnance (UXO) reduction features. These technologies will enable the next generation of cluster munitions to achieve the required greater than 99 percent reliability goal. Evolving DoD emphasis on increased weapon system reliability is driving the need to consider new and novel approaches for achieving increased fuze reliability while maintaining or enhancing fuze design safety. DoD policy, higher weapon	1.475	0.000	1.649

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 204 / *Enabling Fuze Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
reliability expectations and harsher weapon system operational requirements are dictating the need for higher fuze reliability than available using current technologies. ***FY 2018 Plans:*** - Develop liquid reserve lithium oxyhalide battery technology with fast rise time and maintain low temperature performance in weapon applications. - Develop MEMS scale stab detonator and micro-scale firetrain technologies for miniature fuzing applications. ***FY 2019 Plans:*** - Complete development for miniature power source components for area effects weapons. - Demonstrate a highly reliable and robust opto-electrical fuze indicator technology to provide safety status of the munitions for weapon handlers. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase in FY 2019 funding will allow transition of critical fuze components technologies needed to address fuze base single point failures.			
Title: Enabling Fuze Technologies ***Description:*** Develop common/modular fuze architecture; innovative fuze component technologies; sensors; next generation fuze setting capability, tools and modeling; and fuzing power sources. These fuzing technologies will provide smaller, more cost effective solutions while meeting or exceeding the performance of existing technologies. Development of these technologies will enable future weapon applications to be more mission adaptive and smaller along with improved target detection capabilities. ***FY 2018 Plans:*** - Conduct testing on advanced proximity RF algorithms with wideband operation to provide improved weapon target detection accuracy and range. - Develop miniature thermal battery technology to yield fast rise time and high power density required for small munitions. ***FY 2019 Plans:*** - Develop, through additive manufacturing, conformal antennas with wideband operation to provide fuze sensor waveforms for target detection. - Develop non-RF detection and advanced algorithm technologies for fuzing applications for Counter-UAS weapons. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.	1.470	0.000	1.582
Accomplishments/Planned Programs Subtotals	5.713	0.000	6.198

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602000D8Z / *Joint Munitions Technology*	**Project (Number/Name)** 204 / *Enabling Fuze Technology*

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• 0603000D8Z P301: *BA 3 Enabling Fuze Advanced Technology*	6.146	6.588	6.627	-	6.627	6.678	6.781	6.949	-	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

1) Transition of technologies developed by the Program are tracked and documented by technology maturity.
2) Fuze Area Technology Group (FATG) Technology Roadmaps are prepared, evaluated, and analyzed by Joint Fuze Technology Program management and technical staff.
3) Chairman's Annual Assessments for each FATG are critically reviewed by the Technology Assessment Group and Technology Advisory Committee to ensure the JFTP is strategic focused and strong transitions are taking place.
4) Project progress toward goals and milestones is assessed at each FATG meeting.
5) Annual technical reports and papers are tracked and documented for the Program.
6) Technology Transition Agreements in place with Munitions programs.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602230D8Z / *Defense Technology Innovation*

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	9.989	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
835: *Defense Technology Innovation*	0.000	9.989	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program will fund the development of novel leading-edge technologies emerging from high-tech companies that are not traditional defense contractors. These funds will enable the Department to source break through and emerging technologies applicable to the defense mission as identified in the Defense Innovation Unit Experimental (DIUx), or the Components, for potential incorporation into the Department's weapon systems and operational capabilities.

An objective of this program is to obtain innovative ideas from industry that have low technology readiness of high priority to DoD leadership. Incoming proposals will be approved by the Assistant Secretary of Defense, Research and Engineering to ensure alignment with the DoD's strategic objectives and increase our permeability to disruptive change, and strengthen our nation's security.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	30.000	0.000	0.000	-	0.000
Current President's Budget	9.989	0.000	0.000	-	0.000
Total Adjustments	-20.011	0.000	0.000	-	0.000
• Congressional General Reductions	-20.000	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• FFRDC Transfer	-0.011	-	-	-	-

Change Summary Explanation

The DIUx program in this PE and associated funding have been transferred to Washington Headquarters Services (WHS), PE 0603342D8W, beginning in FY 2018.

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602230D8Z / *Defense Technology Innovation*	**Project (Number/Name)** 835 / *Defense Technology Innovation*	

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: *Defense Technology Innovation*	0.000	9.989	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program will fund the development of novel leading-edge technologies emerging from high-tech companies that are not traditional defense contractors. These funds will enable the Department to source break through and emerging technologies applicable to the defense mission as identified in the Defense Innovation Unit Experimental (DIUx), or the Components, for potential incorporation into the Department's weapon systems and operational capabilities.

An objective of this program is to obtain innovative ideas from industry that have low technology readiness of high priority to DoD leadership. Incoming proposals will be approved by the Assistant Secretary of Defense, Research and Engineering to ensure alignment with the DoD's strategic objectives and increase our permeability to disruptive change, and strengthen our nation's security.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Defense Technology Innovation ***Description:*** This program will fund the development of novel leading-edge technologies emerging from high-tech companies that are not traditional defense contractors. These funds will enable the Department to source break through and emerging technologies applicable to the defense mission as identified in the Defense Innovation Unit Experimental (DIUx), or the Components, for potential incorporation into the Department's weapon systems and operational capabilities. An objective of this program is to obtain innovative ideas from industry that have low technology readiness of high priority to DoD leadership. Incoming proposals will be approved by the Assistant Secretary of Defense, Research and Engineering to ensure alignment with the DoD's strategic objectives and increase our permeability to disruptive change, and strengthen our nation's security.	9.989	-	-
Accomplishments/Planned Programs Subtotals	9.989	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602230D8Z / *Defense Technology Innovation*	**Project (Number/Name)** 835 / *Defense Technology Innovation*

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*

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	102.926	46.500	49.748	51.596	-	51.596	52.467	53.480	54.513	55.566	Continuing	Continuing
534: *Lincoln Laboratory*	85.021	38.126	44.275	41.359	-	41.359	42.224	43.141	44.053	44.974	Continuing	Continuing
535: *Technical Intelligence*	17.905	8.374	5.473	6.737	-	6.737	6.743	6.839	6.960	7.092	Continuing	Continuing
815: *Cyber Security, Science and Engineering*	-	0.000	0.000	3.500	-	3.500	3.500	3.500	3.500	3.500	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The Lincoln Laboratory (LL) research line program is an advanced technology research and development effort conducted through a cost reimbursable contract with the Massachusetts Institute of Technology (MIT). The LL Program supports innovative, multi-disciplined research that addresses critical national security problems. The LL Program funds innovations that directly lead to the development of new system concepts, technologies, components and materials in support of Department of Defense (DoD) missions. Funding supports high-risk, high-payoff research, which provides unique and specialized capabilities for the current and emerging needs of the DoD. The project funds ten technology project areas.

Of these, there are five core-technology areas:
• Advanced Devices
• Optical Systems and Technology
• Information, Computation and Exploitation
• Radio-Frequency (RF) Systems and Technology
• Cyber Security, Science and Engineering

There are four emerging-technology initiatives:
• Advanced Materials and Processes
• Quantum System Sciences
• Biomedical Sciences and Technology
• Autonomous Systems

There is one Integrated Systems technology area, which focuses on combining novel component-level technologies to create system-level technology solutions for important DoD problems.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*

These ten technology areas provide critical capabilities that support all DoD mission areas pursued at the Laboratory. The categories are selected in consultation with the Office of the Under Secretary of Defense, Research and Engineering (OUSD(R&E)), are aligned with DoD Communities of Interest (CoI), and with guidance from other DoD agencies to address technology as well as system needs. The research in these categories adapts to solve emerging DoD problems as well as longstanding problems to which new technology advances can be applied. The individual projects in each area are selected with the goal of enhancing DoD capabilities significantly, rather than incrementally.

Supporting these and other priority technology and capability areas are work efforts titled Technical Intelligence:
• The Technical Intelligence Program provides global science and technology (S&T) awareness and context in order to assist the DoD decision-makers plan for an uncertain future. The program uses intelligence-based and open-source information to characterize today's global S&T environment, exploiting novel technology watch and horizon scanning (TW/HS) tools to identify nascent and disruptive technologies that will shape tomorrow's future. The program complements this with tailored technical assessments that identify the military relevance, research opportunities, and policy recommendations for emerging and disruptive technologies.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	48.269	49.748	55.971	-	55.971
Current President's Budget	46.500	49.748	51.596	-	51.596
Total Adjustments	-1.769	0.000	-4.375	-	-4.375
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.709	-			
• Other Program Adjustments	-0.007	-	-4.029	-	-4.029
• FFRDC Transfer	-0.053	-	-	-	-
• Economic Assumption	-	-	-0.346	-	-0.346

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2017**	**FY 2018**
Project: 815: *Cyber Security, Science and Engineering*		
Congressional Add: *N/A*	0.000	0.000
Congressional Add Subtotals for Project: 815	0.000	0.000
Congressional Add Totals for all Projects	0.000	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*

Change Summary Explanation

FY 2019 adjustments include realignment for higher priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			Date: February 2018
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602234D8Z / *Lincoln Laboratory*	Project (Number/Name) 534 / *Lincoln Laboratory*	

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
534: *Lincoln Laboratory*	85.021	38.126	44.275	41.359	-	41.359	42.224	43.141	44.053	44.974	Continuing	Continuing

A. Mission Description and Budget Item Justification

The ten Lincoln Laboratory research areas that comprise the overall research and development portfolio are described below:

Five core-technology areas:

• Advanced Devices emphasizes the development of devices and subsystems utilizing microelectronic, photonic, biological, and chemical technologies to enable new approaches to DoD systems. Projects include technologies for high power RF devices; multi-function, highly integrated lasers; fast and sensitive imagers; and mechanical microsystems for autonomous systems.

• Optical Systems and Technology focuses on developing optical technologies for visible, infrared, and wide band spectroscopic sensing as well as communications systems. The projects areas include high energy lasers; scalable focal plane imaging technology; photonic integrated circuits; optical system prototypes; and associated phenomenology measurements.

• Information, Computation and Exploitation develops novel architectures, tools, and techniques for the processing, fusion, interpretation, computation, and exploitation of multi-sensor, multi-intelligence data. Projects include innovative hardware and software technologies for graph processors and cloud computing; artificial intelligence and graph algorithms for analytics, including deep learning algorithms; multi-intelligence analytics, including open-source data processing techniques; and human-machine interfacing and automation technologies to enhance warfighter effectiveness and ability to work with advanced computing systems.

• RF Systems and Technology focuses on RF technologies to enhance warfighting capabilities in radars, electronic warfare (EW), and communications. Projects include development of next generation phased arrays; ultra-wideband RF systems; compact RF systems; small satellite RF payload; and advanced algorithms for jammer mitigation and EW.

• Cyber Security Science and Engineering Program focuses on the development of technologies and new techniques for the protection of systems against cyber-attack and exploitation. Projects include research into technologies for cyber situational awareness, command and control; technology to improve resilience of systems to cyber-attack; and technologies for system exploitation research.

Four emerging-technology areas:

• Advanced Materials and Processes (formerly Novel and Engineered Materials) emphasizes research in new materials for additive manufacturing and emerging nanoscale materials. Projects include research in microwave circuits built with 3D printing; other advanced 3D printing technologies; one-dimensional semiconductor materials; and microsystems using metamaterials.

• Quantum System Sciences focuses on the development of quantum-based technologies that support sensing, communication, computation, and algorithms using quantum information. The projects include the demonstration of scalable computation platforms, demonstration of quantum protected communications and magnetic field sensing using highly-compact, atomic-like defects in diamond, prototyping revolutionary quantum networking systems and technology, and research into advanced quantum algorithms.

• Biomedical Sciences and Technology supports the development of bio-engineered and biomedical technologies to aid the warfighter. Projects include brain imaging technologies; relevant research in brain and cognitive sciences; engineered biological systems to aid physiology understanding; and technologies to assess physical performance and enhance injury recovery.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

• Autonomous Systems has the objective of developing mobile, autonomous, robotic platforms, as well as sensors and algorithms that support key capabilities needed for a wide range of DoD applications. Projects span advanced artificial intelligence and processing; sensors and communications for unmanned platforms; platform designs and energy systems; human-machine interactions; and verification and validation of autonomous systems.

One system technology area:
• Integrated Systems technology projects use multiple new technologies to solve important national problems. Projects selected for funding have an applied research component focused on integrated technology capability or technologies that facilitate greater levels of integrated capability. Projects target key DoD warfare domains, including space, air, land, sea surface, and undersea.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Advanced Devices ***Description:*** This project area targets the research and development of unique and innovative components, subsystems, and sensing concepts or methodologies that enable new solutions to important DoD problems. Activities under this technology area include specialized silicon and compound semiconductor-based devices for RF, analog, mixed-signal, and digital electronics; photonics, optoelectronics and laser technologies; novel devices and concepts for chemical, biological, and radiation sensing; and micro-hydraulic devices for motors and actuation. ***FY 2018 Plans:*** More sensitive prototypes of larger format imagers integrated with small-pitch read-out integrated circuits (ROICs) will be developed. Subsystem demonstrations of photonic-integrated gyroscopes will measure the gyroscope accuracy and reliability. Prototype circuits of a new class of high-power, diamond-based wideband transistors will help evaluate the promise of this technology. Gallium nitride (Ga N)-based photonic components operating at blue-green wavelengths will be matured and demonstrated in system prototypes. Projects for FY 2018 include developing higher performing substrates for infrared devices; developing pixel arrays that integrate germanium detectors with silicon integrated circuits for more capability at each pixel; and prototyping a new, highly compact clock that will aid in navigation and timing for small platforms. ***FY 2019 Plans:*** Chemical sensing technology and blue-green laser developments begun in FY 2017 will conclude in FY 2019 with the demonstration of technology prototypes. This project area expects new applied research in the areas of magnetic imaging for advanced microscopes, more flexible and higher performing optical sensors, superconducting electronics, and other advanced devices. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.	4.500	5.391	5.099
Title: Optical Systems and Technologies ***Description:*** This project area conducts applied research and develops novel concepts, technologies, and systems to be used in next-generation optical systems for the DoD. Investments in optical-based technologies can fill the critical technology gaps	4.577	5.540	5.600

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
in emerging DoD threat areas, such as anti-access/area denial (A2/AD), counter–weapons of mass destruction (C-WMD), and asymmetric warfare. Optical systems and technologies will also improve capabilities using new tactics, techniques, and procedures (TTPs) in traditional DoD mission areas such as intelligence, surveillance, and reconnaissance (ISR), space control, communications, and ballistic missile defense. ***FY 2018 Plans:*** Optical Systems and Technology will continue to develop technologies for high-energy lasers (HEL) that are finding many defensive and offensive DoD applications including blinding sensors and other countermeasures. Research in computing-intensive algorithms as well as more capable focal plane arrays will demonstrate higher resolution images. Until now, a laser radar on a large aircraft produced three-dimensional (3D) images only after hours of processing on the ground. Development of a small laser radar in FY 2018 will allow real-time 3D images on a small unmanned air vehicle. Microwave radars with multiple receivers have many advantages including multiple look angles, stealthy receivers, and higher resolution. Research with simultaneous microwave beams and optical beacons will explore techniques to overcome synchronization and coherent combining difficulties. The ability for wavelength agility will become as important in the optical domain as it is for microwave electronic warfare. So, development of multi-wavelength imaging spectrometers, long-wavelength infrared laser radars, and wavelength-agile short pulse lasers will provide continued capability growth while ensuring that deployed countermeasures in overused optical regions will not thwart DoD capabilities. ***FY 2019 Plans:*** Design will commence on integration of a 3D laser radar into an unmanned air vehicle. Continue development on optical coherent combining which will enable a wide variety of applications in areas of HELs, optical imaging, multi-wavelength signal processing, and communications. Although coherent combining of optical beams is many decades old, technology has only recently advanced enough to enable many DoD applications. The most promising of these will be developed in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.			
Title: Radio Frequency (RF) Systems and Technologies ***Description:*** This project area focuses on research, development, and evaluation of innovative RF technologies and system concepts for radar, signals intelligence, electronic warfare, and communications. Emerging national security challenges include a rapidly expanding threat spectrum, the increasing need to integrate sensors on platforms with severely constrained payloads, military operations in strong clutter and interference environments, detection and long duration tracking of difficult targets, and robustness against sophisticated electronic countermeasures. To address these new mission requirements, future RF systems will need to operate with increased bandwidth, higher dynamic range, higher-frequency bands, and lower size, weight and power (SWAP).	3.661	4.195	4.200

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: RF Systems and Technology will continue to focus research on advanced RF technologies in support of emerging needs for radar, electronic intelligence (ELINT) communications, and electronic warfare (EW) systems. The major research areas include: advanced RF arrays that deliver higher power and efficiency; wideband receivers for ELINT applications; simultaneous transmit and receive technology to enable multifunction RF systems; micro-hydraulic-jet technology for RF electronics cooling; and algorithm techniques for RF countermeasures. ***FY 2019 Plans:*** The GaN on Si CMOS technology development will continue with an advanced prototype test. The wideband ELINT receiver development will continue, with a major intermediate milestone to demonstrate a prototype breadboard. The fiber-combining RF array project will develop critical enabling components. This project area expects new applied research in electronic warfare algorithms, transmit beam processing to increase RF system flexibility and performance, applications of 3D manufacturing to RF components, and other RF capability areas. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.			
Title: Information, Computation, and Exploitation Sciences ***Description:*** This project area achieves technical gains in data processing, computation, exploitation, and information visualization for DoD applications. The volume, velocity, and variety of information production and consumption are growing at exponential rates. Novel computing architectures, hardware and analytical techniques provide tools to process "big data". These tools for high throughput processing, fusion, interpretation, and exploitation of "big data" are applied to both real-time and stored multi-sensor, multi-intelligence data sets. ***FY 2018 Plans:*** Several highly publicized attacks on computer networks were promulgated using unsecured Internet of Things (IoT). In FY 2018, an IoT project will prototype resilient cloud computing techniques in IoT networks to protect military systems. Advanced machine learning efforts will expand to national security environments where tagged training data are sparse. Sparse data introduces hurdles that are not being addressed in the commercial world. The new techniques will help the warfighter make better decisions based on current knowledge in a timely way. New real-time processing approaches such as the graph processor effort will reduce size, weight, and power (SWAP) to allow advanced analytics to be deployed at the tactical edge. ***FY 2019 Plans:*** Transition of the graph processor technology to use in the Supercomputing Center will be completed to test. Also, work will continue to focus on providing enough information for decision making at the tactical edge through increased efficiency of available information and machine learning techniques. Applied research will continue on the use of deep learning techniques for	5.089	5.788	5.860

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
data exploitation, with an emphasis on designing algorithms that are both efficient and that can explain their decision processes to humans. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.			
Title: Biomedical Sciences and Technology ***Description:*** This project area develops advanced biomedical technology and systems to address health needs to enhance warfighter resilience and sustainability. The projects exploit expertise in advanced signal processing, optoelectronics, systems engineering and analysis, biology and chemistry, and other fields to develop novel methods and devices for interrogating and understanding physiological and cognitive aspects of the human domain. The overarching goal of these efforts is to increase human performance and prevent or predict injury through improved understanding of the biological mechanisms of disease and injury and through individualized biological monitoring, analysis, and interventions. ***FY 2018 Plans:*** Advance understanding of the human brain, developing better diagnostics for cognitive load assessment and illnesses like mild Traumatic Brain Injury (mTBI), and improving field forward casualty care will facilitate diagnostics for and improvements in warfighter health and resilience. Several efforts are augmenting the Brain Research through Advancing Innovative Neuro-technologies (BRAIN) initiative being led by the Defense Advanced Research Projects Agency (DARPA) and The National Institutes of Health (NIH), and include the development of algorithms for cellular resolution brain mapping, the design and prototyping of neuron-size, biocompatible sensors for in-vivo neural monitoring, as well as the design and development of novel sensors for imaging systems to make them portable for use in the field and office to diagnose post-traumatic stress or brain injury, and to conduct real time cognitive load assessment for the warfighter. Sensorimotor tracking of neurological disorders in a large virtual reality environment is informing the detection of mTBI, with a focus on transitioning a simplified version of the capability to clinical settings. Other efforts are targeted at developing and implementing novel model systems and sensors, medical support tools, and the application of big data analytics to areas such as medical image analysis. Novel model systems and sensors include: the Lincoln Laboratory Artificial Gut that is helping to decipher the complex relationship between the nervous system and the microbiome, which has been correlated with depression and stress, as well as neuro-generative diseases including Parkinson's Disease; and development, design and prototyping of an engineered sensor platform capable of real-time monitoring of health biomarkers in the body or in body fluids. Novel medical support tools include: a novel hearing aid design that uses deep neural networks to reduce the cognitive burden of isolating a single speaker in background noise, which is of relevance for normal and hearing impaired warfighters; and implementation of artificial intelligence to develop a system for field forward casualty care that reduces the burden on medics providing combat casualty care. ***FY 2019 Plans:***	4.166	4.812	5.100

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Better understanding and harnessing of Human Machine Interfaces (HMI) will become increasingly important for the DoD. The Laboratory will incorporate results of the FY 2018 Laboratory HMI systems analysis study to chart a path forward to address identified knowledge and capability gaps aligned with DoD needs. Biomedical Sciences and Technology will continue to place an increasing emphasis on multimodal data collection and analysis in diverse application areas for example, cognitive and neuroscience, microbiome-related, tissue healing, in keeping with emergent science trends and anticipated DoD needs. The increased understanding will also aid in treatment of soldiers with traumatic brain and other battlefield injuries. This project area will continue to develop concepts and technologies in medical sensing, imaging, and diagnostics, cognitive analytics, and cellular and molecular engineering. Multimodal approaches to understanding physiological and psychological status will continue. Novel tool and platform development focused on accelerating and improving biotechnology research will also continue. Medical image processing and rehabilitation tools will be explored by leveraging existing Laboratory expertise in image processing, signal analysis, and decision support algorithms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in funding will accommodate expected additional research, informed by the Laboratory's HMI systems analysis study, as this is a significant growth area for the DoD, and ensure the successful continuation and continued results of ongoing projects.			
Title: Autonomous Systems ***Description:*** This project area addresses current and anticipated DoD mission needs in autonomous robotics. In DoD environments, unmanned systems must perform useful tasks as trusted, capable agents without continuous human operator control. Projects include development of autonomy algorithms and technologies, such as perception and world modeling, planning, human-robot interaction, manipulation, learning and adaptation, and robotic platforms. ***FY 2018 Plans:*** Coordination of robot swarms will continue to add features that allow optimization of goals even with a great deal of uncertainty for example, "the fog of war". These improvements rely on continuing research in multi-agent coordination and machine learning algorithms. One learning algorithm project will emulate biological thinking for adapting to changing knowledge. Advances in autonomous systems rely not only on improved algorithms, but also better interfaces between hardware and algorithms, as well as more suitable hardware. This project area will conduct research into better tactile interfaces for grasping and manipulation, with an additional focus on building autonomous systems that will perform within prescribed performance bounds. These research thrusts will have important applications in autonomous robot augmentation for the warfighter. Also, being aware that the noise of an autonomous Unmanned Aerial Vehicle (UAV) can compromise its mission, work on an electroaerodynamic (EAD) propulsion system will lead to sustained noiseless flight. In addition, a study will provide an autonomous undersea mapping framework for future efforts. ***FY 2019 Plans:***	3.401	3.904	4.100

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
As autonomous systems play an increasingly important role in the DoD, work in autonomous undersea mapping will rely on new algorithms, new autonomous undersea vehicles, and communications to interface between distributed sources of information and distributed, multiple agents. Research on EAD UAVs will continue to improve performance and make the system more robust. Incorporation of algorithms from the commercial world will hasten the development of autonomous systems for the DoD. Incorporation of technology improvements from the commercial world will lead to improvements in lower Size, Weight, Power and Cost (SWaP-C) systems. Novel energy harvesting strategies will be explored to support a variety of missions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.			
Title: Quantum System Sciences ***Description:*** This project area develops methods for sensing, communicating, and processing information using quantum mechanical manipulation not possible with classical computing techniques. Collaborations with major university quantum system science efforts are establishing a robust scientific foundation. On this foundation, application-oriented developments important for national security are being fostered. ***FY 2018 Plans:*** A unique feature of quantum mechanical manipulation is the correlation property, particularly for entangled states. Research takes advantage of these states to produce secure quantum networks and quantum computers, which, in principle, can do calculations far beyond the ability of any classical computer. A quantum communications system has been built over an in-ground fiber in the Boston metropolitan area. This system will continue to develop and test a robust and secure quantum network with applicability to a secure core network for the DoD. Quantum computing could have important implications for solving DoD problems that are intractable on classical computers. Multiple techniques for overcoming technical difficulties are being investigated. For example, advances in control and measurement of trapped ion and superconducting qubits will enable the development of noise correlation measurements and error correction techniques. These advances are a requirement for quantum computers. FY 2018 plans also include design of a fieldable, high-precision vector magnetometer based on advances in quantum magnetometry. This project area will also investigate electric field measurements that are based on the same physics and that employ much the same hardware as used for the magnetometer. ***FY 2019 Plans:*** Research will place an emphasis on approaches to do quantum state transfer between a trapped ion and photon and leverage the ions for quantum sensing and quantum clocks. A linchpin for both quantum networks and quantum computers is the ability to manipulate robust quantum memories. Advances in quantum memories will build on the improved control and measurement techniques of FY 2018. Improved measurements based on sub-shot noise interferometry using entangled states will enhance microwave links over optical fiber, which has important applications for remoting of antennas. FY 2019 plans also include scaling	4.437	5.160	5.200

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
quantum computer prototypes and investigating improved control and error correction mechanisms, as well as developing increased bandwidth quantum networking capability. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.			
Title: Advanced Materials and Processes ***Description:*** This project area (formerly named Novel and Engineered Materials) develops materials and processes that make a transformative impact on enduring national challenges. Areas of strategic focus are material property customization and material enablers for much lower SWaP systems. ***FY 2018 Plans:*** Lincoln Laboratory leverages additive manufacturing for materials discovery and property customization. Research into multimaterial fibers showed in FY 2017 unique long-wavelength properties. When woven into cloth in FY 2018, the cloth should make soldiers significantly less visible to heat-sensing cameras. This project area recently developed materials with large optical property changes in sub-millisecond times. Lincoln Laboratory continues to FY 2018, we will develop prototypes to improve this capability. Further work in FY 2018 will apply these materials to DoD and IC applications. This project area will conduct research into ”valleytronic” materials, which have the potential to deliver extremely low-power memory and computing capability. ***FY 2019 Plans:*** Gaining proper understanding of valleytronic materials will require several years of research. This project area will conduct research and development of new valleytronic materials and phenomenology. The project will also develop novel fibers with unique physical, chemical, or biological properties that can be integrated into fabric or other materials, which could revolutionize warfighter protection and capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019.	2.500	3.075	3.100
Title: Integrated Systems ***Description:*** This project area combines multiple new technologies to solve important national needs. Projects selected for funding have an applied research component focused on integrated technology capability or technologies that facilitate greater levels of integrated capability. Projects target key DoD warfare domains, including space, air, land, sea surface, and undersea. The intent is to support early work on systems that cut across the conventional categories. ***FY 2018 Plans:*** This project area will continue two projects from FY 2017 and evolve two projects from other technology areas. The undersea laser communications project will refine the pointing-and-tracking technology needed to accomplish narrow beam	2.295	2.910	3.100

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
communications, and will do in-water testing of a communication network between multiple moving platforms. The 3D space-based ladar effort will continue with risk reduction in key areas, including data-registration for forming 3D image and space optics technology. The project will accelerate the design of a future generation micro-air vehicle (MAV) for integrating advanced power, guidance, control, and payloads. Maturation of wafer-scale integration processes will lead to development of designs for applying these processes to small satellite systems. ***FY 2019 Plans:*** The four efforts will continue in FY 2019. The undersea laser communication project will conclude with a multiple undersea vehicle communication demonstration. The 3D ladar project will complete risk reduction activities (described above) and will proceed to a preliminary design review for a critical space surveillance mission. The future generation MAV project will focus on integrating advanced sensing payloads and advanced autonomous system processing control algorithms. The plan is to develop a highly integrated wafer-scale small satellite bus with a basic payload. This satellite bus will be a highly integrated capability with embedded thrusters, control, and space for small form factor payloads. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in funding in FY 2019 will accommodate increased development costs of maturing projects.			
Title: Cyber Security, Science and Engineering ***Description:*** The Cyber Security Science and Engineering Program focuses on the development of technologies and new techniques for the protection of systems against cyber-attack and exploitation. Projects include research into technologies for cyber situational awareness, command and control; technology to improve resilience of systems to cyber-attack; and technologies for system exploitation research. ***FY 2018 Plans:*** Plans include advancing the capability to discover and rapidly respond to cyber vulnerabilities, as well as improving significantly the design and architecture of embedded computer systems and data management systems, which will facilitate improvements in DoD cyber security and resilience. Research into novel approaches for computer hardware/software design will guide the design and development of a fundamentally new computing system that is inherently secure and can ensure mission success even when compromised. This effort will be complemented by developing a data-centric approach to ensuring self-protection of data throughout storage, computation and transit. Research into cyber resilient approaches for mission assurance includes the development and implementation of a secure processing engine for autonomous systems, and the development and validation of an automated capability for contested environments where a host may be disabled or compromised. Other cyber efforts include further developing the capability to automatically generate effective cyber courses of action for evolving threat environments such as damage by an attacker after network penetration, securing small satellites against the growing threat of cyber-attack, and	3.500	3.500	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 534 / *Lincoln Laboratory*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
securing the ability to compute on private data without revealing it and demonstrating this capability for a Department of Homeland Security (DHS) application. ***FY 2019 Plans:*** Cyber efforts will move to an individual project code starting in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no notable changes between FY 2018 and FY 2019, where the latter is reported in an individual project code starting in FY 2019.			
Accomplishments/Planned Programs Subtotals	38.126	44.275	41.359

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 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602234D8Z / *Lincoln Laboratory*	Project (Number/Name) 535 / *Technical Intelligence*

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
535: *Technical Intelligence*	17.905	8.374	5.473	6.737	-	6.737	6.743	6.839	6.960	7.092	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Technical Intelligence Program supports the strategic intelligence analysis through providing global science and technology (S&T) awareness and context in order to inform Defense technology, engineering & acquisition decision-makers planning for an uncertain future. The program exploits novel technology watch and horizon scanning (TW/HS) tools to identify nascent and disruptive technologies that will shape tomorrow's future by integrating intelligence-based and open-source information to characterize today's global S&T environment, this characterization, in combination with other technical analysis, will inform strategic decisions for capability development. The program complements this with tailored technical assessments that identify the military relevance, research opportunities, and policy recommendations for emerging and disruptive technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Technical Intelligence	8.374	5.473	6.737

Description: The Technical Intelligence Program supports the strategic intelligence analysis through providing global S&T awareness and context in order to inform Defense technology, engineering & acquisition decision-makers planning for an uncertain future. The program exploits novel TW/HS tools to identify nascent and disruptive technologies that will shape tomorrow's future by integrating intelligence-based and open-source information to characterize today's global S&T environment, this characterization, in combination with other technical analysis, will inform strategic decisions for capability development. The program complements this with tailored technical assessments that identify the military relevance, research opportunities, and policy recommendations for emerging and disruptive technologies.

FY 2018 Plans:

In FY 2018, the Technical Intelligence program will continue to support efforts characterizing today's global S&T environment, exploiting novel TW/HS tools to identify nascent and disruptive technologies that will shape tomorrow's future, and developing tailored technical assessments that identify the military relevance, research opportunities, and policy recommendations of emerging and disruptive technologies. Specifically:

• TW/HS Tool Exploitation: ($3.5M) will continue to support the operational TW/HS toolkit, TechSight, which is available to DoD researchers and scientists, and focus on expanding it to provide quicker data analytics for TW/HS to support decision making through the inclusion of DoD contract, small business innovation research (SBIR) and grant award information. These developments will allow for strategic analysis of S&T and acquisition investments to inform technology, engineering, & acquisition decisions. The program will identify outreach opportunities to inform and train DoD S&T organizations in the usage of analytical tools and methodologies to support "in-house" decision making and expand organizational knowledge into emerging technology areas of strategic interest.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 535 / *Technical Intelligence*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Technical Assessment Program: ($0.5M) will sponsor multiple technical assessment activities that support the community of interest topic areas and more emphasis will be placed on conducting impact assessments of emerging technologies. These assessments will inform the S&T community on direction for future capabilities to support joint and cross domain missions. • Intel Support to S&T: ($1.0M) will provide a bridge between the intelligence community (IC) and the S&T community to access the most relevant intelligence analysis, coordinate integration of intelligence with capability development, and conduct Red Cell assessments to inform technology investment shaping and strategic direction. An additional function will be to produce an annual S&T Intelligence Needs Plan providing the IC a formal understanding of intelligence requirements for the R&D community. • Wargaming: ($0.5M) will integrate emerging threats from kill chain analysis and potentially disruptive technologies from horizon scanning efforts through the DoD wargaming community to better understand the potential of emerging technologies to better inform both the DoD requirements process and the technical capability development process. ***FY 2019 Plans:*** In FY 2019, the Technical Intelligence program will continue to support efforts characterizing today's global S&T environment, exploiting novel TW/HS tools to identify nascent and disruptive technologies that will shape tomorrow's future, and developing tailored technical assessments that identify the military relevance, research opportunities, and policy recommendations of emerging and disruptive technologies. Specifically: • TW/HS Tool Exploitation: ($4.7M – Additional Data sources) will continue to support the operational TW/HS toolkit, TechSight, which is available to DoD researchers and scientists, and focus on developing data analytics on the commercial sector through analyzing venture capital, private equity and commercial investments in R&D. • Technical Assessment Program: ($0.5M) will sponsor multiple technical assessment activities that support the community of interest topic areas and more emphasis will be placed on conducting impact assessments of emerging technologies. These assessments will inform the S&T community on direction for future capabilities to support joint and cross domain missions. • Intel Support to S&T: ($1.0M) will provide a bridge between the intelligence community (IC) and the S&T community to access the most relevant intelligence analysis, coordinate integration of intelligence with capability development, and conduct Red Cell assessments to inform technology investment shaping and strategic direction. An additional function will be to produce an annual S&T Intelligence Needs Plan providing the IC a formal understanding of intelligence requirements for the R&D community. • Wargaming: ($0.5M) will integrate emerging threats from kill chain analysis and potentially disruptive technologies from horizon scanning efforts through the DoD wargaming community to better understand the potential of emerging technologies to better inform both the DoD requirements process and the technical capability development process. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase resources to support technology watch and horizon scanning in order to inform the DoD R&D investments.			
Accomplishments/Planned Programs Subtotals	8.374	5.473	6.737

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 535 / *Technical Intelligence*

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 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 815 / *Cyber Security, Science and Engineering*	

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
815: *Cyber Security, Science and Engineering*	-	0.000	0.000	3.500	-	3.500	3.500	3.500	3.500	3.500	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Cyber Security Science and Engineering Program focuses on the development of technologies and new techniques for the protection of systems against cyber-attack and exploitation. Projects include research into technologies for cyber situational awareness, command and control; technology to improve resilience of systems to cyber-attack; and technologies for system exploitation research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Cyber Security, Science and Engineering ***Description:*** The Cyber Security, Science and Engineering Program conducts research, development, evaluation, and deployment of prototype components and systems designed to improve the security of computer networks, hosts, and applications, thereby assuring the resilience of Department of Defense (DoD) missions against cyber-attack and exploitation. A particular focus is the overlap between the DoD mission areas and the cyber domain. Efforts include cyber analysis; creation and demonstration of robust architectures that can operate through cyber-attacks; development of prototypes that demonstrate the practicality and value of new techniques for cryptography, cyber sensing, automated threat analysis and course of action selection, anti-tamper systems, and malicious code detection; demonstrations of the impact of cyber on traditional kinetic systems; quantitative, repeatable evaluation of these prototypes; and, where appropriate, deployment of prototype technology to national- and international-level exercises and DoD and intelligence community operations. ***FY 2018 Plans:*** Cyber efforts were previously funded under Project P534 in FY 2018 and prior. ***FY 2019 Plans:*** Plan to improve the capability to rapidly respond to evolving cyber threats and new technology trends, and guide future plans for cyber security. Further develop the design and architecture of novel cyber resilient computer systems and data management systems, as well as capabilities and tools to support mission assurance. Plan is to focus on big data analytics in support of cyber situational understanding and effective, timely decision making; these capabilities will play a key role in future applied research. Continue to develop prototype cyber decision support systems that can automatically generate effective cyber security courses of action to protect systems under attack. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.000	0.000	3.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602234D8Z / *Lincoln Laboratory*	**Project (Number/Name)** 815 / *Cyber Security, Science and Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
No notable change between FY 2018 (under Project P534) and FY 2019			
Accomplishments/Planned Programs Subtotals	0.000	0.000	3.500

	FY 2017	FY 2018
Congressional Add: N/A	0.000	0.000
FY 2017 Accomplishments: N/A		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*

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	-	40.798	49.226	60.688	-	60.688	53.356	54.385	55.315	56.363	Continuing	Continuing
227: *Applied Research for the Advancement of S&T Priorities*	-	40.798	49.226	60.688	-	60.688	53.356	54.385	55.315	56.363	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities program element (PE) enables the early launch of S&T applied research projects to shape Components' investments. The PE focuses on the design, development, and improvement of prototypes and new processes to achieve general mission requirements and to translate promising research into solutions for military needs. Additionally, the PE enables concept exploration efforts and studies of alternative concepts. The research projects are aligned with the Department of Defense (DoD) S&T priorities and designated focus areas that include non-system specific technology efforts and feasibility assessments and are formulated and managed by teams of subject matter experts drawn from the Office of the Secretary of Defense, the Military Services, and the Defense Agencies. The PE also provides support to the S&T Communities of Interest (CoI).

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	42.206	49.226	53.060	-	53.060
Current President's Budget	40.798	49.226	60.688	-	60.688
Total Adjustments	-1.408	0.000	7.628	-	7.628
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.356	-			
• FFRDC Transfer	-0.046	-	-	-	-
• Other Program Adjustments	-0.006	-	-0.018	-	-0.018
• Economic Assumption	-	-	-0.354	-	-0.354
• High Priority Program	-	-	8.000	-	8.000

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** 227 / *Applied Research for the Advancement of S&T Priorities*

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
227: *Applied Research for the Advancement of S&T Priorities*	-	40.798	49.226	60.688	-	60.688	53.356	54.385	55.315	56.363	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities program was established to implement Department-wide technology development portfolios and foster Tri-Service research areas of common interest within cross-cutting S&T efforts. The program has three investment areas: (1) large, three-year applied research programs selected by the S&T Executives; (2) smaller, two-year technology 'seedling' programs nominated by the Communities of Interest (CoIs) to address technology gaps or opportunities; and (3) technical support to the CoIs. The execution of the program by the Office of the Secretary of Defense (OSD) and the support it provides to the CoIs assures strategic oversight and multi-agency coordination.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Applied Research for the Advancement of S&T Priorities	30.000	42.000	44.646

Description: The program focuses on fostering Tri-Service research areas of common interest within cross-cutting S&T efforts that give the joint warfighter a technological advantage in the fight. It is intended to focus on emerging areas of science, to build experience within Department of Defense laboratories, to include investment in laboratory infrastructure and people, and will be a foundation for further investments by the Services following the completion of the projects.

Cross-cutting efforts align with the S&T Priorities, such as Electronic Warfare, Human Systems, Autonomy, and Cyber, as well other focus areas, such as Advanced Materials, Biomedical, Weapons, Quantum, and Command, Control, Communications, Computers and Intelligence.

FY 2018 Plans:
Continue concept exploration efforts that focus on the S&T priority areas. The challenge areas within the priorities include:

Quantum Science and Engineering Program (QSEP) ($15.000 million): Will complete three-year research project;
− Enhance the performance of silicon carbide quantum memories through the use of isotopically pure elements in the crystal growth process;
##− Demonstrate spin-photon entanglement using silicon carbide crystals as the photon source;
− Improve quantum dot material properties to enhance the indistinguishably of photons#, which is an important property of photons that enables the design and fabrication of more advanced quantum repeaters and quantum communication experiments;
− Conduct single and dual stage frequency conversion with single photons to improve the transport of photons through telecommunications fiber and allows coupling of disparate quantum systems;
− Demonstrate a quantum repeater with four quantum memory system;

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** 227 / *Applied Research for the Advancement of S&T Priorities*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
− Analyze ion-photon interface to enable long-distance quantum communication and demonstrate remote entanglement in a trapped in experiment. Synthetic Biology for Military Environments (SBME) ($15.000 million): − Continue efforts to establish a biological open system architecture and chassis relevant to military environments and to create a cell-free system for gene network optimization; − Develop transcriptomic, proteomic and metabolomic tools. The tools will be applied to identify chassis network architectures, measure compensatory changes, and determine circuit yields; − Design complex circuits and initiate the synthesis, incorporation, and testing of the circuit; − Initiate the validation and optimization of the circuits in both cell-based and cell-free platforms; − Explore ruggedization of the cell-free platform to improve stability for storage and field use; − Continue iterations of in silico predictions, test bed optimization and in vivo validation; these testing scenarios will be used to establish calibration transfer between systems; − Complete baseline measurements of the simple circuits in chassis organisms and extend the circuit designs to produce modulating output. Defense Optical Channel Program (DOC-P) ($11.000 million): − Evaluate bandwidth and power efficient waveforms for laser communications; − Begin development of lab tools that emulate measured channel data (effects of scintillation/weather) with high fidelity; − Begin development of chip scale circuit prototype for optical frequency comb and investigate optical clock designs for small size, weight and power implementation; − Integrate atmospheric propagation physics and optical beam control principles with quantum information theory to define capabilities, limitations, and technology requirements for Quantum Key Distribution (QKD) protocols; − Assess commercial-off-the-shelf based testbed with adaptive spatial filtering for daylight QKD demonstration; − Develop technical requirements for Quantum receiver/transmitter testbed. Select and initiate FY 2018 Applied Research for the Advancement of S&T Priority Project ($1.000 million). ***FY 2019 Plans:*** Continue concept exploration efforts that focus on the S&T priority areas. The challenge areas within the priorities include: Synthetic Biology for Military Environments (SBME) ($15.000 million): Will complete three-year research project. − Optimize chassis organisms with respect to production of synthesis products and fitness for targeted environments; − Refine tools within the open system architecture;			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
− Increase characterization throughput of engineered circuits in both chassis organisms and cell free platforms; − Develop specialized characterization approaches; − Test additional circuits using the cell-free platform; − Refine transcriptomic, proteomic and metabolomic tools; − Select a strategy for ruggedization of the cell-free platform to improve stability for storage and field use; − Document completed circuits; − Document the findings. Defense Optical Channel Program (DOC-P) ($18.000 million): − Develop and assess adaptive laser communications protocols for tolerance to dynamic and intermittent contacts; − Begin Space-Ground laser communication scintillation characterization; − Laboratory demonstration of microwave photonics modulation of lasercom payload; − Integrate atmospheric propagation physics and optical beam control principles with quantum information theory to define capabilities, limitations, and technology requirements for Quantum Entanglement Distribution; − Integrate classical/quantum channels and prototype atomic-line spectral filter; − Begin engineering and outfitting of Startfire Optical Range (SOR) optical comm facility for Quantum Key Distribution demonstration. Continue FY 2018 Applied Research for the Advancement of S&T Priority Project ($11.000 million). Select and initiate FY 2019 Applied Research for the Advancement of S&T Priority Project ($1.000 million). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increased amount of $3.000 million from FY 2018 to FY 2019 will support the DOC-P research effort. This provides the DOC-P project with the required $30.000 million for the second full-year of the project's timeline.			
Title: S&T Communities of Interest (CoIs) ***Description:*** The S&T CoIs effort facilitates cooperation and collaboration among Components; it optimizes the development of critical S&T efforts across the DoD enterprise. The efforts include the development of technology roadmaps and the integration of technology planning. The CoIs select and examine critical technology areas to address gaps or opportunities. ***FY 2018 Plans:*** Continue to provide technical support to CoIs.	10.798	7.226	8.042

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** 227 / *Applied Research for the Advancement of S&T Priorities*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Conclude Seedling projects initiated in FY 2017, and select a new set of Seedling projects to address gaps identified by the CoIs. Concluding Seedling Projects are: Preparing for Enhanced Energetic Materials: An affordable CL-20: The singular solution to range and energy challenges is to make both propellant formulations (for range) and explosive formulations (for energy) using the most powerful, mature energetic crystal, CL-20. Current use of CL-20 is extremely limited because of its cost of large-scale manufacture ($1,000/lb). The proposed work intends to achieve new, cheaper, high-yield, production routes to CL-20. - Research CL-20 production with fewer organic synthesis reactions, thereby reducing production costs; these reactions will employ commercially available metal catalysts, instead of the current expensive Palladium catalyst required. - Pursue the CL-20 precursor known as TetraAcetylDiAminohexaazaisowurtzitane (TADA), utilizing commercial off-the-shelf (COTS) starting materials. - Work on small-scale mixing of CL-20 propellant formulations to achieve reasonable viscosity, pot life, mechanical and safety properties. Development of Prototype Soft Epidermal Biosystems with Advanced Sensing Capabilities for Warfighters in Triage Settings: To develop a wireless epidermal system that integrates flexible electronics and a range of biosensors to provide rapid vital sign screening solution for battlefield triage of combat casualties. - Development of stretchable circuit and biosensor designs. - Integration of soft elastomeric substrates and fluidic channel. - Validation of porcine animal model and test conditions for future evaluation of novel epidermal biosystems. - Evaluation of epidermal biosystems in porcine animal models and clinical settings. ***FY 2019 Plans:*** Continue to provide technical support to CoIs. Select a new set of Seedling projects to address gaps identified by the CoIs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increased amount of $0.816 million from FY 2018 to FY 2019 will support one additional Seedling project in FY 2019.			
Title: Additive Manufacturing (AM) of Energetics ***Description:*** Additive manufacturing (AM) of energetics provides the ability for tailored and integrated munitions with enhanced capabilities. Integration of unique printed structures and printed energetics with smart fusing can allow for more agile manufacturing processes with reduced development times. As a cross-service area of interest, the Department of Defense (DoD) Communities of Interest in Materials and Manufacturing Processes and Weapons Technologies have engaged in discussions to	0.000	-	8.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** 227 / *Applied Research for the Advancement of S&T Priorities*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
identify areas of collaboration. In order to rapidly advance additive manufacturing of energetics, a joint effort across the services and the Department of Energy would support the programs interested in AM of energetics, such as Program Executive Office for Ammunition, Next Generation Hand-Grenade, Harpoon, and Lightweight torpedo. ***FY 2019 Plans:*** Explore preliminary concepts of low volume direct write energetics within smart fusing in tailored AM structures. In addition, systemically explore the relationship between low volume direct write energetics and tailored AM metallic structures. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a single year investment effort from the DoD in FY 2019.			
Accomplishments/Planned Programs Subtotals	40.798	49.226	60.688

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Project performance metrics specific to each effort are identified in the project plans established by the program leads and the Communities of Interest. Individual project success will be monitored through these metrics.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602668D8Z / *Cyber Security 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
Total Program Element	-	11.906	14.775	14.969	-	14.969	15.162	15.443	15.712	16.010	Continuing	Continuing
003: *Cyber Applied Research*	-	11.906	14.775	14.969	-	14.969	15.162	15.443	15.712	16.010	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

United States military forces require resilient and reliable networks, information, and weapons systems to conduct effective operations. However, the number and sophistication of threats in cyberspace are rapidly growing, making it critical to improve the cybersecurity of all Department of Defense (DoD) systems to counter those threats and assure the Department's missions. The Cyber Applied Research program focuses on innovative and sustained research in both cybersecurity and computer network operations to: develop new concepts to harden key network and computer components, design new and resilient cyber infrastructures, increase the military's ability to disrupt, fight and survive nation-state actors' cyber-attacks, measure the state of health in cybersecurity, and explore and exploit new ideas in cyber warfare for agile cyber operations and mission assurance, along with the ability to protect tactical networks, weapons systems and platforms.

This program is unique in that it integrates both the defensive and offensive cyber research from each of the Services to develop interoperable, defense-wide technology options targeted to meet Combatant Command needs and requirements. More specifically, by increasing cross-laboratory collaboration, this program is able to take Service-specific technologies and expand their applications to the Joint Force.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	12.183	14.775	15.075	-	15.075
Current President's Budget	11.906	14.775	14.969	-	14.969
Total Adjustments	-0.277	0.000	-0.106	-	-0.106
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.262	-			
• FFRDC Transfer	-0.013	-	-	-	-
• Other Program Adjustments	-0.002	-	-0.005	-	-0.005
• Economic Assumptiom	-	-	-0.101	-	-0.101

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602668D8Z / *Cyber Security Research*

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602668D8Z / *Cyber Security Research*	**Project (Number/Name)** 003 / *Cyber 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
003: *Cyber Applied Research*	-	11.906	14.775	14.969	-	14.969	15.162	15.443	15.712	16.010	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Cyber Applied Research program was initiated in FY 2011 to address specific technical problems that were not being fully addressed by the Services' and the National Security Agency's existing Cyber science and technology (S&T) investments. Recently, S&T gaps were enumerated and described in several studies, including the 2015 DoD Cyber Strategy, the 2016 Commission Enhancing National Cybersecurity, and the 2017 Defense Science Board Research Enterprise Assessment.
The Cyber Applied Research program builds upon existing basic and applied research results. Over the past several years, the program expanded research in cyber capabilities to provide Warfighters and commanders with tools and technologies to enable cyber situational awareness, cyber command-and-control, cyber operations, and protection of tactical networks, weapons systems and platforms. From FY 2011 to FY 2017, the program explored a number of technical thrusts that included:

• Foundations of Trust: Developing known degrees of assurance that devices, networks, and cyber-dependent functions perform as expected, despite attack or error.

• Resilient Infrastructure: Exploring technologies that not only withstand, but react to cyber attacks, and sustain or recover critical functions.

• Assuring Effective Missions: Developing technologies that assess and control the cyber situation in mission context while staging, conducting, and monitoring cyber responses.

• Cyber Modeling, Simulation & Experimentation: Simulating environments in which the Department operates and enables a more robust assessment and validation of the cyber technology development.

• Embedded, Mobile & Tactical Environments: Exploring cyber systems that rely on technologies beyond wired networking and standard computing platforms.

As adversaries develop more sophisticated technology tactics and become more skilled and better funded, the Cyber S&T Community must remain agile, vigilant, and evermore creative in response. Starting in late FY 2016, the Department reviewed the emerging needs of the joint operational community, new cyber threats, and the evolution DoD technology needs to focus the program on the changing cyber environment and missions. To bolster this program and address future threats, a new strategic vision was developed to enhance the DoD's tactical edge in the rapidly evolving cyber domain where many aspects still remain unexplored. Seedling projects under the new research areas were initiated in late FY 2017. Judiciously investigating aspects of this research in thrusts areas identified below will provide a distinct advantage in future cyber conflicts:

• Behavioral Cyber Sciences: Exploring the interaction between computers and human behavior by moving beyond signals (ones and zeroes) towards understanding human behavior. New insights from behavioral sciences will increase the effectiveness of tools, the cyber workforce, and improve the utility of cyber solutions. Behavioral cyber sciences seeks to uncover details about how humans (to include operators, users, adversaries, and/or defenders) react to cyber actions and how those reactions can be understood from a behavioral science standpoint and leveraged to create more effective actions and outcome.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602668D8Z / *Cyber Security Research*	**Project (Number/Name)** 003 / *Cyber Applied Research*

• Self-securing weapons, systems, and networks: Prevailing in a contested cyber environment will require new sciences and mechanisms for autonomous cybersecurity to keep pace with the growing complexity of weapon systems and help the DoD operators react more quickly to cyber-attacks. Autonomous cyber defenses will need to apply the recent advances in artificial intelligence research.

• Foundations of precision cyber operations: Precision bombing campaigns for the cyber domain require accurate and timely predictions of cyber effects to enable DoD leadership to achieve the desired effects of cyber operations and help manage risks associated with collateral damage.

• Mathematical Foundations of Cyber Security: Advancing mathematical foundations of cyber S&T will cut across focus areas and produce new methods to design, secure, and reason about complex cyber systems.

Advances in these new cyber S&T focus thrust areas will help to promote strong foundations and disruptive innovations that will create surprises, shape the fight, and ensure a decisive advantage. The research areas will be critical to the development of innovative and sustainable research that takes cyber security beyond the incremental escalation of attack and defense.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Foundations of Trust ***Description:*** Developed approaches and methods to establish known degrees of assurance that devices, networks, and cyber missions performed as expected, despite attack or error. This technical area encompassed all aspects of the assessment, establishment, propagation, maintenance, and composition of trust relationships between devices, networks, and people. Achieving a trustworthy cyberspace was a critical challenge as corporations, agencies, national infrastructure, and individuals have been victims of cyber-attacks, which exploit weaknesses in technical infrastructures as well as in human behavior. This effort built upon long term foundational basic research in algorithms, models, probability theory, reliability, statistical theory and analysis, system structures, and secure computing, developing and enabling trustworthy cyber systems. Research in algorithms helped develop methods to manipulate automated image processing computation using Scanning Electron Microscopes (SEMs), accelerating graphics processing unit (GPU) analysis. The development and compilation of GPU tools into a library provided meta-learning capabilities that were used to improve trust in digital electronics.	0.977	-	-
Title: Resilient Infrastructure ***Description:*** Resilient Infrastructure entailed the ability to withstand cyber attacks and to sustain or recover critical functions. This provided the ability to continue to perform functions and provided services at required levels during an attack. The objective in this area was to develop integrated architectures that were optimized for their ability to absorb cyber shock and recover in a timely fashion to a known secure state with well-defined performance characteristics. Resilient algorithms and protocols increased the repertoire of resiliency mechanisms available to the infrastructure and architecture. Research was needed to develop resiliency at lower levels with specific algorithms and protocols to support higher-level resilient architectures.	1.466	-	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602668D8Z / *Cyber Security Research*	**Project (Number/Name)** 003 / *Cyber Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Funded research under the Tactical Platform Cyber Resiliency project, developed techniques for furnishing resiliency on critical real-time control systems against cyber-attacks. Through the enhancement of existing fault tolerance on physical systems, known as Byzantine Fault Tolerance (BFT), combinations of artificial, manipulated crashes, and delayed input evolved a level of tolerance to enforce resilience. The successful collaboration with Siemens transitioned the technology to the Naval Capability Program, Resilient Hull, Mechanical, and Electrical Security (RHIMES), which is now supports the NATO Sea Sparrow program. Under the Network PUMP-II project, research explored the challenges of optimizing enterprise based data sharing requirements for the tactical war-fighter and intelligence missions. The project developed a cost effective, high throughput government-off-the-shelf cross domain solutions that provided the war-fighter with improved sensitive data correlation and intelligent data decision capabilities. The technology is transitioning to the Naval Air Systems Command, Triton Unmanned Aircraft System Program Office.			
Title: Assuring Effective Missions ***Description:*** Assuring Effective Missions presented technology challenges in the areas of Cyber Mission Control and Effects at Scale. Within this thrust, research was developed to assess and control the cyber situation within a military mission context. Cyber Mission Control covered the ability to orchestrate cyber systems to achieve an overarching mission goal by developing tools and techniques that enabled models of cyber operational behaviors (cyber and kinetic) to determine the correct course of action in the cyber domain. Effects at Scale encompassed full spectrum challenges that intersected with cyber becoming a new full-fledged domain of warfare. Funded research under the Mission Assurance Research Collaboration (MARC), a U.S.-Australia cyber effort to enhance mission assurance through data enrichment, deep learning and natural language processing. The research developed dynamic mission mapping capabilities that were later integrated into Talisman Sabre 2017 (TS17). As a result, the MARC team successfully captured ~12 terabytes (TB) of operationally relevant, shareable data that it will use to analyze for future research. This massive data set represents a huge asset to the future of this five-year collaboration. Additionally, the team established relationships with I-CORPS and Deployable Joint Command and Control (DJC2) as the network providers for the exercise, laying the groundwork for capability demonstration, test, and evaluation in future exercises. ***FY 2018 Plans:*** MARC activities will focus on revising its mission assurance architecture and designing the MARC experiment for Talisman Saber 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Research within this area will complete in FY 2018.	4.275	0.300	-
Title: Cyber Modeling, Simulation & Experimentation (MSE)	1.865	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Developed modeling and simulation capabilities that were able to sufficiently simulate the cyber environment in which the DoD operates and enables a more robust assessment and validation of cyber technology development. There were two technical challenges associated with cyber MSE: 1) Cyber Modeling and Simulation, and 2) Cyber Measurement. Cyber Modeling and Simulation sought to develop tools and techniques that enabled analytical modeling and multi-scale simulation of complex cyber systems. Cyber Measurement developed cyber experimentation and test range technology to conduct controlled, repeatable experiments, providing the ability to track the progress of cyber research investments in a quantitative fashion. This area explored new analytical methodologies, models, and experimental data sets to establish metrics to measure a system's state of security, applying the scientific method to establish the foundations of a framework in which cyber security research could be conducted, to test hypotheses with measurable and repeatable results, and the quantitative experimentation and assessment for new cyber technologies. These new methodologies enabled the exploration of modeling and simulation tools and techniques that drove innovation in research. Additionally, these methodologies aided in integrating experimentation by simulating the cyber environment with sufficient fidelity and integrating cyber modeling and simulation with the traditional modeling and simulation related to the kinetic domain. Funded research under the Metrics, Instrumentation and Emulation for Cyberspace Operations, Electronic Warfare (EW) and Communications/Networking project developed a selected set of vignettes and scenarios to understand the complex interactions between red and blue networks. The metrics derived from analyzing these scenarios were used to better inform future design choices in cyberspace, EW, and communications systems. The dynamic scenarios developed under this research are being migrated into to a distributed test-bed to support development of analytical tools.			
Title: Embedded, Mobile & Tactical Environments (EMT) ***Description:*** Increased the focus of cyber S&T on DoD cyber systems that relied on technology beyond wired networking and standard computing platforms. The objective in the area of embedded and tactical systems was to develop tools and techniques that assured the secure operation of microprocessors within our weapons systems and platforms; enabled security in real-time systems; and established security in disadvantaged, intermittent, and low-bandwidth environments. This research also sought to expand and cultivate military-grade techniques for securing and operating enterprise commodity mobile devices, such as smartphones, tablets, and their associated infrastructures. With the constant evolution of these devices and their respective infrastructures it was of the utmost importance to provide a secure environment where these devices could be effectively utilized, monitored and tracked. The Resilient and Assured Unmanned Aerial Systems Operations (RAUSO) project developed technologies to harden unmanned aerial systems (UAS) platforms and provided better cyber awareness to operators through the integration of a number of cyber tools and capabilities. The approach leveraged a high-assurance hardware platform developed under the Assured Resilient Embedded Systems (ARES) program, to build a cyber security module software stack capable of monitoring sensor inputs and	2.346	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
process behavior, while responding with security-relevant actions. The technology has been incorporated into the ARES platform and is being considered for a General Electric (GE) Aviation flight control system, with possible flight tests in FY 2018.			
Title: Behavioral Cyber Sciences ***Description:*** The point where hardware, software, and humans interact has become a jumping off point for a new area of research – behavioral cyber science. Cyber operations should be seen in the context of a larger socio-behavioral-technical domain. Research in behavioral cyber science seeks to advance the understanding and technical rigor of modeling and predicting human responses to cyber activities and to discover ways to inject this understanding into the human aspects of cyber operations, cyber defense systems, planning, and training. Future research must broaden the scope beyond the impacts of cyber actions on equipment, and also include the impact that these cyber actions will have on broader human behavior. Just as an adversary's behavior may be better understood using behavioral cyber science, behavioral science can be utilized to help understand ways to improve the actions of cyber defenders and the performance of the cyber workforce. Data gleaned from observing effects of various cyber operations on users' productivity, performance, and security will help the cyber workforce design better techniques and processes for use in cyber defense. ***FY 2018 Plans:*** Begin execution of Joint research effort aimed at addressing scientific challenges, to broaden the scope of cyber activities through an understanding of human behavioral sciences and its responses to cyber effects. Research will focus on human performance for cyber, developing techniques to measure effectiveness of cyber tools and cyber mission planning based on behavior of network defenders; human responses to cyber effects, identifying and documenting human responses to cyber defense and offense activities; and evidence-based validation, which identifies behavioral responses to network activity that correlate with information on network security and readiness. ***FY 2019 Plans:*** Continue the development of behavioral cyber science research with follow-on efforts from early FY 2017 and FY 2018 with a large scale study to derive statistically-relevant results. Incorporate insights into research prototypes to analyze early results in mission-simulated settings. Codify sound methodological approaches to accurately address cyber challenges that identify communities of risk; improve efficiency/effectiveness of cyber teams to cyber-attack; and research the impact of social engineering as a major vulnerability. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Additional resources will allow for completion of the development phase of the projects under the thrust.	0.391	3.700	3.774
Title: Self-securing Weapons, Systems, and Networks ***Description:*** The pervasive nature of software-reliant systems in today's modern military creates new opportunities for sophisticated adversaries. The vast majority of DoD weapons systems, platforms, and networks rely on software to operate.	-	5.775	5.788

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Software can often be disrupted remotely, which necessitates a new kind of security to protect against cyber-attacks. Defending the software- and network-based aspects of critical weapon systems is challenging for a number of reasons, chief among which is the advanced nature of the adversary in the cyber realm. The Department can expect future cyber adversaries to be well-funded, well-informed, and agile. Building weapon systems, platforms, and networks that can defend themselves in real time will be vital in protecting ourselves against the adversary. The DoD needs systems that will autonomously monitor and manage their own health and security posture through advanced sensing and perception, reasoning, and planning. Such systems could identify and classify threats much more quickly than a human operator, and therefore, be able to neutralize the threat more quickly and effectively. However, researchers must be cognizant of the potential unintended consequences of turning security over to autonomous systems. Verification techniques must be developed to ensure that autonomous and dynamic system changes maintain correct mission-focused capabilities without introducing unintended vulnerabilities. Conversely, developing techniques to track and audit actions taken by autonomous systems is crucial to ensure that direct control can be reasserted, potentially reversing actions, if necessary. ***FY 2018 Plans:*** Begin execution of Joint research effort aimed at developing novel adaptive techniques to model adversary options and predict the security of future system configurations, even under unknown attacks; develop cyber immunology so that systems can monitor health and develop identification/classification mechanisms for cyber threats; develop autonomy methods and self-healing techniques couple with rigorous experimentation; develop experimental approaches to prove robust and unique metrics; and use advanced modeling and simulation to develop and validate cyber security metrics. ***FY 2019 Plans:*** Continue developing novel adaptive techniques that focus on a system's ability to reason about its own security and take action without immediate human inputs; explore self-healing techniques associated with Internet of Things (IoT) devices with largely unattended sensing, computation, storage, and heavy machine-to-machine (M2M) communication. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase will allow the program to complete the development phase of projects under the thrust.			
Title: Foundations of Precision Cyber Operations ***Description:*** When compared to traditional methods of kinetic warfare, cyber conflict is still relatively new and untested. Cyber operators often have incomplete information about their target prior to completing an action. The lack of a complete picture makes it difficult to predict the precise outcomes or collateral damage caused by a cyber operation. In this type of uncertain environment, military leaders may be acting with an undue sense of caution in using cyber capabilities. Improved technology and techniques for quantifying cyber effects, estimating their cost and effectiveness, predicting consequences, and ensuring precise effects will help both to limit collateral damage and to ensure that a chosen action has the intended effect upon the adversary. Highly precise and	0.586	3.000	3.367

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
predictable cyber effects can also achieve mission goals despite the presence of both incomplete and maliciously-created false information. ***FY 2018 Plans:*** Begin execution of Joint research effort aimed at developing greater precision and accuracy of cyber effects to achieve targeted cyber mission impacts. Research will focus on developing modeling techniques, based on limited data, capable of predicting the range of possibilities that unfold due to a planned cyber effect; developing methods to collect technical information from in-accessible cyber systems, while employing covert deceptive techniques; developing methods to identify key pieces of missing information to advance situational awareness; developing abductive reasoning techniques; developing intelligent systems that can reason and provide actionable guidance despite the presence of both incomplete and maliciously-created false information; developing methods for autonomous cyber operations to provide enhanced control and execution that allow cyber operators to timely and accurately respond to events. ***FY 2019 Plans:*** Continue research in modeling techniques that support effects planning, and its ability to characterize systems, networks, devices, and software from a distance. The ability to establish a course of action before an effect is deployed is critical to its use, developing methods to collect technical information from inaccessible cyber systems, while employing covert deceptive techniques; will develop methods to identify key pieces of missing information to advance situational awareness. Will Identify rapid methods to developing actionable guidance despite incomplete information. Will develop methods for autonomous cyber operations to provide enhanced control and execution that allow cyber operators to timely and accurately respond to events. MARC activities will focus on developing and refining tools to incorporate into its mission assurance architecture and designing the MARC experiment for Talisman Sabre 2019 Exercises. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase will allow the program to further develop methods and tools for autonomous cyber operations.			
Title: Mathematical Foundations of Cyber Security ***Description:*** Mathematical Foundations of Cyber Security research is needed to help characterize the cyber domain and cyber security, maintain the integrity of data, harden systems, and analyze potential solutions. Continued research in mathematical theory beyond the "basic research" level is crucial to maintain and increase the security of cyber systems. Mathematics is intrinsically linked to all branches of science and technology including cyber security research. There is a need for an array of modeling techniques, both informal and formal, backed by various rigorous mathematical theories, to capture and support the richness of the cyber domain. ***FY 2018 Plans:***	-	2.000	2.040

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Execution of a Joint research effort aimed at developing and enhancing foundational work underpinning cyber technology in the areas of advanced mathematics. Possible research areas include mathematical logic and formal methods; network science; information theory; decision sciences; risk analysis; and modeling and simulation. ***FY 2019 Plans:*** Development of research areas under mathematical logic and formal methods, where modeling techniques identify salient features satisfied by systems. Research will investigate the capacity of overt and covert channels in an effort to address cyber security challenges using information theory to provide rigorous interpretations of a machine's channel capacities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase will allow the program to complete the development phase of projects under the thrust.			
Accomplishments/Planned Programs Subtotals	11.906	14.775	14.969

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

- Number of publications in refereed journals and peer reviewed reports or conference proceedings;
- Number of external research collaborations and interactions with the broader cyber community;
- Transition of tools, techniques and methodologies for use in DoD, Federal or commercial entities;
- Improved technology readiness levels; and
- Affordability.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602751D8Z *I Software Engineering Institute (SEI) 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
Total Program Element	-	8.105	8.955	9.300	-	9.300	9.608	9.692	9.791	9.844	Continuing	Continuing
278: *Software Engineering Institute (SEI) Applied Research*	-	8.105	8.955	8.300	-	8.300	8.608	8.692	8.791	8.844	Continuing	Continuing
817: *Cyber Security, Applied Research*	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

Software is a key to meeting the Department of Defense's (DoD) increasing demand for high-quality, affordable, and timely national defense systems. With growing global parity in software engineering, the DoD must maintain leadership to avoid strategic surprise. To assist the DoD in retaining a long-term differential advantage over potential adversaries, the Software Engineering Institute (SEI) Applied Research program element (PE) develops and evaluates the feasibility and practicality of software and computer science concepts, with the potential to improve future DoD systems. The research conducted by this PE directly benefits the technical domains such as Command, Control, Communications, Computers, and Intelligence (C4I), Autonomy, Cyber, and Engineered Resilient Systems.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	8.420	8.955	9.365	-	9.365
Current President's Budget	8.105	8.955	9.300	-	9.300
Total Adjustments	-0.315	0.000	-0.065	-	-0.065
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.305	-			
• FFRDC Transfer	-0.009	-	-	-	-
• Other Program Adjustments	-0.001	-	-0.003	-	-0.003
• Economic Assumption	-	-	-0.062	-	-0.062

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 278 / *Software Engineering Institute (SEI) 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
278: *Software Engineering Institute (SEI) Applied Research*	-	8.105	8.955	8.300	-	8.300	8.608	8.692	8.791	8.844	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work conducted under this PE will enable resilient mission assurance in heterogeneous and contested environments through the verification and validation of system performance and architecture. The program will also assist the DoD in retaining a long-term advantage in the areas of software-intensive systems and cybersecurity by enhancing assurance, exploiting automation, and understanding human-computer interaction.

The SEI Applied Research PE has two main research thrusts with known military applications: 1) Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance) and 2) Information Assurance.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: SEI Applied Research in the Area of Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance) ***Description:*** This thrust seeks to develop verification techniques for requirements identification, systems of systems architectures, and virtual integration of components. Additionally, research in this area will enable requirements verification for software assurance, analysis and control of unverified code, and automated repair of damaged code. Software production and code analysis methods developed through this program will also improve the accuracy of behavior prediction of complex software system in untested environments. Increasingly numerous lines of code will require a commensurate increase in sophistication of verification and validation mechanisms. ***FY 2018 Plans:*** In FY 2018 there will be two main lines of effort: create verification and validation research solutions focused on time-sensitivity and reliability for safety-critical systems; and create containment technology that will enable software systems to continue to function under duress. ***FY 2019 Plans:*** In FY 2019, plans will include developing formal methods for explaining decision patterns in planning and learning systems, thus maximizing human-machine teaming effectiveness, developing and building benchmarks and datasets, using emerging machine learning computing technologies for evaluating and enhancing decision making systems, and developing techniques to assess risks and greatly increase the pervasiveness and adaptability of programmability in devices and Information Technology systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	6.686	7.152	6.023

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 278 / *Software Engineering Institute (SEI) Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The decrease in budget from FY 2018 to FY 2019 reflects the release of resources as prototyping efforts in containment technologies conclude.			
Title: SEI Applied Research in the areas of Information Assurance (IA) ***Description:*** Information assurance ensures the integrity of information and data produced by software. Software developed from an unknown supply chain may include intentionally or unintentionally introduced vulnerabilities. This thrust seeks to develop scalable automated methods to locate, understand, and mitigate the effects of these vulnerabilities. Automated solutions developed through this thrust will be used to discover vulnerabilities in system software (binary only) and to generate proofs of correctness or fault. Additionally, they will be used to model and simulate operational environments to support software and cyber tactics, techniques, and procedures testing. ***FY 2018 Plans:*** In FY 2018, this project will develop technologies to increase the resiliency and assurance of software intensive systems. This includes improvement in data analytics development and deployment, including scalability, data bias control and mitigation. ***FY 2019 Plans:*** In FY 2019, this project plans to develop advanced analytics and machine learning technologies to enable self-adaptive cyber defenses that can evade and confuse adversaries. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in budget from FY 2018 to FY 2019 reflects additional resources required for technology maturation efforts.	1.419	1.803	2.277
Accomplishments/Planned Programs Subtotals	8.105	8.955	8.300

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• BA 3, PE# 0603781D8Z: *Software Engineering Institute (SEI)*	13.726	15.047	15.151	-	15.151	15.267	15.398	15.570	15.874	Continuing	Continuing

Remarks

The SEI Applied Research PE represents a pivot toward more fundamental research that enables the DoD to address longer-term challenges in software technology and engineering. The SEI Applied Research PE bolsters the organic research at the SEI Federally Funded Research and Development Center (FFRDC), enables stronger collaborations between the SEI FFRDC and academia, attracts top researchers to the SEI, and gives the DoD access to top experts in information science, which generally enhances the DoD's ability to benefit from the military applications of research in software and computer science.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 278 / *Software Engineering Institute (SEI) Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics for this project include the transition of solutions, methods, and practices for use in DoD technology development programs and programs of record; the transition of solutions, methods, and practices to the Defense Industrial Base to support DoD technology development programs and programs of record, the number of citations in peer reviewed journals and reports, and the number of external research collaborations and interactions with the broader software and computer science community.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 817 / *Cyber Security, 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
817: *Cyber Security, Applied Research*	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work conducted under this project will enable resilient mission assurance in heterogeneous and contested environments through the verification and validation of system performance and architecture. The program will also assist the DoD in retaining a long-term advantage in the area of cybersecurity by enhancing assurance, exploiting automation, and understanding human-computer interaction.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Cyber Security ***Description:*** Warfighting in the cyber domain often operates at sub-second timescales and across multiple domains of authority. Methods used to accomplish many tasks (e.g., malware analysis, coordinating multiple agents) demand large amounts of time, attention, and special skills and are not scalable. This thrust seeks to develop and increase the use of automation to simplify the completion of these tasks. Example activities include automation of moving target defenses, code artifact reverse engineering, analysis of network flows at enterprise scale, and development and assessment of workforce skills. ***FY 2019 Plans:*** This program will create tools and methods to automatically identify, mitigate, and repair unique vulnerabilities (including those from malware or deliberate nefarious interference) in software-enabled DoD systems (including emerging systems reliant on machine learning). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no notable change in the Cyber investment between FY 2018 and FY 2019. Note the Cyber effort was funded in Project P781 in FY 2018.	-	-	1.000
Accomplishments/Planned Programs Subtotals	-	-	1.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 817 / *Cyber Security, Applied Research*

E. Performance Metrics

Metrics for this program include transition of tools, methods, and practices for use in DoD technology development programs and programs of record; transition of tools, methods, and practices to the Defense Industrial Base to support DoD technology development programs and programs of record; the number of citations in peer reviewed journals and reports; and the number of external research collaborations and interactions with the broader software and computer science community.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced 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	102.136	23.742	25.627	25.598	-	25.598	25.853	26.235	26.696	27.202	Continuing	Continuing
002: *Insensitive Munitions Advanced Technology*	82.134	17.643	19.039	19.052	-	19.052	19.260	19.539	19.865	20.277	Continuing	Continuing
301: *Enabling Fuze Advanced Technology*	20.002	6.099	6.588	6.546	-	6.546	6.593	6.696	6.831	6.925	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

This program addresses advanced technology development associated with improving the lethality, reliability, safety, and survivability of munitions and weapon systems. The goal is to develop and demonstrate joint enabling technologies that can be used by the Program Executive Offices (PEO) as they develop their specific weapon programs. The program invests in and demonstrates technologies from a Joint Service perspective, thus maximizing efficiencies, ensuring the development of technology with the broadest applicability while avoiding duplication of efforts.

Munition Area Technology Groups (MATGs) and Fuze Area Technology Groups (FATGs) have been established for each munition and capability area and are tasked with: 1) coordinating, establishing, and maintaining 2018 and 2023 year technology development plans and roadmaps, 2) coordinating biannual meetings to review technical and programmatic details of each funded and proposed effort, 3) developing and submitting Technology Transition Agreements in coordination with appropriate PEO for insertion in their Insensitive Munition (IM) Strategic Plans / Fuze Technology Development Plan, and 4) interfacing with other MATGs / FATGs and IM / fuze science and technology projects as appropriate. The Joint Insensitive Munitions Technical Program (JIMTP) and Joint Fuze Technical Program (JFTP) will utilize a Technical Advisory Committee (TAC) (consisting of senior Department of Defense (DoD) and Department of Energy (DOE) laboratory representatives and senior Munitions PEO representatives) to provide program oversight, policy, direction, and priorities during its annual meeting.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	23.902	25.627	25.779	-	25.779
Current President's Budget	23.742	25.627	25.598	-	25.598
Total Adjustments	-0.160	0.000	-0.181	-	-0.181
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Other Program Adjustments	-0.134	-	-0.009	-	-0.009
• FFRDC Transfer	-0.026	-	-	-	-
• Economic Assumption	-	-	-0.172	-	-0.172

Change Summary Explanation

FY 2019 adjustments are reflective of minor budget adjustments..

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 002 / *Insensitive Munitions Advanced 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
002: *Insensitive Munitions Advanced Technology*	82.134	17.643	19.039	19.052	-	19.052	19.260	19.539	19.865	20.277	Continuing	Continuing

Note

SRRB efficiencies are included.

A. Mission Description and Budget Item Justification

The Insensitive Munitions (IM) effort addresses advanced technology development associated with improving the lethality, reliability, safety, and survivability of munitions and weapon systems. The goal is to develop and demonstrate joint enabling technologies that can be used by program managers as they develop their specific weapon programs. The program invests in and demonstrates technologies from a Joint Service perspective, thus ensuring the development of technology with the broadest applicability while avoiding duplication of efforts – providing efficiencies and cost savings for the Department.

This effort will demonstrate enabling technologies needed to develop weapons in compliance with IM requirements established in United States Code, Title 10, Chapter 141, Section 2389 and DoD Instruction 5000.1 and 5000.02. This effort will take promising technologies demonstrated at the laboratory scale and transition them into demonstration programs utilizing generic hardware based on priority munitions identified in the Program Executive Office (PEO) IM Strategic Plans. Mature demonstrated IM technology can be transitioned, thereby decreasing their program costs and schedule risk and facilitating spin-offs to other non-compliant munitions within their portfolios.

The Joint Insensitive Munitions Technology Program (JIMTP) investments focus on five Munition Areas: 1) High Performance Rocket Propulsion, 2) Minimum Signature Rocket Propulsion, 3) Blast and Fragmentation Warheads, 4) Anti-Armor Warheads, and 5) Gun Propulsion. Munition Area Technology Groups (MATG), under tri-service leadership, have developed technology roadmaps for each Munition Area which is used to guide investments based on goals consistent with the DoD IM Strategic Plan. These IM technologies, alone or in combination, will be incorporated in hardware, simulating real-world munitions, to demonstrate their utility and feasibility as part of Technology Transition Agreements with PEOs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High Performance Rocket Propulsion (HPP) ***Description:*** HPP focus on the development and demonstration of technologies to improve the IM response of HPP systems, rocket motors with Ammonium Perchlorate and with or without a metal fuel, for rockets and missiles launched from air, ground, and sea platforms. These technologies, when applied to rocket motors, improve IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, rocket propellant ingredients, including synthesis, characterization and scale-up; reduced smoke or smoky propellants, including formulation, characterization and scale-up; rocket motor case design; materials for active and passive thermal mitigation; shock mitigation materials and techniques; passive and active coatings; active and passive venting techniques	3.680	3.761	3.761

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
for motor cases or containers; ignition systems; sensors; and thrust mitigation techniques. Operating conditions may be controlled or widely varying in both temperature and vibration. The 2023 and 2028 year goals of the HPP MATG are concentrated on solving the IM response of missile propulsions systems due to Fragment Impacts and Slow Cook Off for the majority of High Performance Propulsion rocket motors, and solving the Fast Cook Off response of very large High Performance Propulsion motors. ***FY 2018 Plans:*** - Solving the IM response of missile propulsions systems due to Fragment Impacts and Slow Cook Off (SCO) for the majority of High Performance Propulsion rocket motors. - Solving the Fast Cook Off (FCO) response of very large High Performance Propulsion motors. - Finalize design for 7" rocket motor thermal venting using novel rocket case design. - Development of multiple candidate formulations for Divert and Attitude Control System (DACS) lethality requirements. - Survivability testing of sub-scale DACS motor. ***FY 2019 Plans:*** - Design and ballistic testing of a HD 1.3 propellant in a new DACS for Missile Defense Agency. - Demonstrate venting solution for large rocket motor casing applicable to sidewinder and AMRAAM. - Demonstrate SCO/FCO improvement and firing of MK-135 Tomahawk boost motor. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Minimum Signature Rocket Propulsion (MSP) ***Description:*** MSP focuses on the development and demonstration of technologies to improve the IM response of MSP systems. The development and demonstration of minimum signature (MS) rocket technologies, when applied to munition systems, will improve munition IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, MS rocket propellant formulations; ingredients for MS propellant formulations, including synthesis, characterization and scale-up; case and packaging design; active and passive venting techniques; rocket motor case design; ignition systems; and thrust mitigation techniques. Of particular interest are technologies toward higher burning rate MS propellants with state-of-the-art energy and reduced shock sensitivity. The 2023 and 2028 year goals of the MSP MATG are concentrated on solving the IM response of missile propulsion systems due to Fragment Impact, Slow Cook Off, and Shaped Charge Jet (SCJ) threats. ***FY 2018 Plans:*** - Solving the IM response of missile propulsion systems due to Fragment Impact, SCO, and Shaped Charge Jet (SCJ) threats.	2.051	2.431	2.431

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 002 / *Insensitive Munitions Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Design of extruded double base motor for close combat propulsion using novel processing equipment. - Demonstration of low cost composite case with thermal venting for dual pulse motors. - Demonstration of shock mitigating shipping containers for hellfire improvement to Fragment Impact. ***FY 2019 Plans:*** - Development and shock testing of extruded propellant to improve Fragment Impact response of TOW flight motor. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Blast and Fragmentation Warheads (BFW) ***Description:*** BFW focus on the development and demonstration of technologies to improve the IM response of BFW munitions. The development and demonstration of explosive ingredients, explosives, and warhead and fuze technologies, when applied to munitions, improve IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, new ingredient synthesis and characterization, initial formulation development, scale-up, warhead/charge configuration, venting techniques for both munitions and their containers, protection / packaging materials and systems, shock mitigation liners, initiation devices, techniques, and technologies. Applications vary but include high performance warhead fills, booster explosives, bulk demolition charges, and bulk fills for blast and/or fragmentation charges. Munition operating conditions may be controlled or have widely varying environmental conditions, such as temperature and vibration, and other factors such as cost, availability, and reliability may be critically important depending on the intended munition application. The 2023 and 2028 year goals of the BFW MATG are concentrated on solving the IM response of blast fragment warheads to the Sympathetic Detonation, Fragment Impact, and SCJ threats. ***FY 2018 Plans:*** - Solving the IM response of blast fragment warheads to the Sympathetic Detonation, FCO, and SCJ threats. - Build and demonstration of shock barriers for current and future shoulder launch weapons. - Demonstrate the thermal improvement to the BLU-109 penetrating weapon using outgassing and vent. ***FY 2019 Plans:*** - Development of improved Fragment Impact response with lethality enhancement for indirect fire munitions using novel explosives and warhead design. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.	6.965	7.558	7.472
Title: Anti-Armor Warheads (AAW)	3.298	3.515	3.614

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 002 / *Insensitive Munitions Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: AAW focuses on the development and demonstration of explosive ingredients, explosives, and warhead and fuze technologies for improving Insensitive Munitions (IM) of AAW munitions. The development of explosive ingredients, explosives, and warhead and fuze technologies, when applied to munitions, improve IM response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, new ingredient synthesis and characterization, initial formulation development, scale-up, warhead/charge configuration, venting techniques for both munitions and their containers, protection/packaging materials and systems, shock mitigation liners, and initiation devices, techniques, and technologies. Applications vary, but include high performance warhead fills, booster explosives, and all other technology to mitigate the violent response of AAW munitions to IM threats. Munition operating conditions may be controlled or have widely varying environmental conditions, such as temperature and vibration, and other factors such as cost, availability, and reliability may be critically important depending on the intended munition application. The 2023 and 2028 year goals of the AAW MATGs are concentrated on solving the IM response of anti-armor warheads to the Fragment Impact and Slow Cook-off, threats for larger and Medium Caliber Munitions. ***FY 2018 Plans:*** - Solving the IM response of anti-armor warheads to the Fragment Impact, Sympathetic Reaction, and Shaped Charge Jet threats for larger munitions and the Fragment Impact, Slow Cook-off, and Sympathetic Reaction / Shaped Charge Jet threats for Medium Caliber Munitions. - Firing demonstration of 155mm anti-access/aerial denial (A2/AD) cannon capability. ***FY 2019 Plans:*** - Demonstrate full IM improvement to 40mm sub-munition for 155mm carrier rounds with DPICM capability. - Demonstrate improved SCO response of medium caliber munitions using SMA technology. - Demonstrate improved safety of underwater neutralizing charges using novel energetics. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding will be used to accelerate the Dual-Purpose Improved Conventional Munition (DPICM) replacement cannon round capability project to demonstrate a 99% reliability for an insensitive munitions compliant the system.			
Title: Gun Propulsion (GP) ***Description:*** GP focuses on the development and demonstration of technologies in the area of GP systems. The development and demonstration of gun propulsion technologies, when applied to munition systems, will improve munition Insensitive Munitions (IM) response to one or more threats, while not degrading the response to other IM threats and, at minimum, maintaining munition performance. Technologies include, but are not limited to, gun propellant formulations, ingredients for gun propellant formulations (including synthesis, characterization and scale-up), cartridge case and packaging design, active and passive venting techniques, reduced sensitivity primer propellant and primer systems, and robust primers for insensitive propellants. Applications vary, but	1.649	1.774	1.774

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 002 / *Insensitive Munitions Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
include both large and medium caliber munitions, as well as propelling charges for mortars and shoulder launched munitions. Operating requirements vary, and other factors such as barrel life and operation over varying environmental conditions may be critically important depending on the intended munition application. The 2023 and 2028 year goals of the GP MATG are concentrated on solving the IM response of gun propulsion munitions to Fragment Impact and Slow and Fast Cook threats. ***FY 2018 Plans:*** - Solving the IM response of gun propulsion munitions to Fragment Impact and SCO threats. - Demonstrate IM compliant propulsion system for current and future Fire from enclosure Military Operations in Urban Terrain (MOUT) weapons. - Demonstration of propulsion system for extending range and accuracy of 120mm mortars. ***FY 2019 Plans:*** - Demonstrate weight and cook off improvement for medium caliber propulsion systems. - Demonstrate improved FI and SCO venting and packaging for 120mm tank rounds. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Accomplishments/Planned Programs Subtotals	17.643	19.039	19.052

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• 0602000D8Z P000: *BA2 Insensitive Munitions*	11.993	12.910	13.037	-	13.037	13.178	13.362	13.618	13.889	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

1) Transition of technologies developed by the program are tracked and documented by technology maturity.
2) MATG Technology Roadmaps are prepared, evaluated, and analyzed by JIMTP management and technical staff.
3) Chairman's Annual Assessments for each MATG are critically reviewed by the Technical Advisory Committee (TAC) to determine progress, transition plans, and relevance of each project.
4) Project progress toward goals and milestones is assessed at each MATG meeting.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 002 / *Insensitive Munitions Advanced Technology*

5) Annual technical reports and papers are tracked and documented for the Program.
6) External Peer Reviews of Projects are conducted as part of Joint Army/Navy/NASA/Air Force meetings.
7) Technology Transition Agreements are in place with Munition programs.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 301 / *Enabling Fuze Advanced 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
301: *Enabling Fuze Advanced Technology*	20.002	6.099	6.588	6.546	-	6.546	6.593	6.696	6.831	6.925	Continuing	Continuing

A. Mission Description and Budget Item Justification

This effort will demonstrate fuze enabling technologies needed to develop weapons that address priority capability areas identified in the Guidance for Development of the Force, the Secretary of Defense Memorandum, DoD Policy on Cluster Munitions and Unintended Harm to Civilians, and shortfalls in current weapon systems. This effort will take promising technologies integrated and tested to technology maturity and demonstrate the technologies to technological maturity utilizing weapon hardware based on priority capabilities and technology needs identified and validated by the Program Executive Officers (PEOs) and the Heads of the Service Science and Technology (S&T) communities. Mature demonstrated fuze technology will be transitioned, thereby decreasing their program costs and schedule risk and facilitating spin-offs to other munitions within their portfolios. Under the Joint Fuze Technology Program (JFTP), investments are focused on specific capability areas that have been identified by Department strategic guidance and current shortfalls in weapon systems and validated by the PEOs and Heads of the Service S&T communities. These four capability areas are: 1) Hard Target Survivable Fuzing, 2) Tailorable Effects (TE) Weapon Fuzing, 3) High Reliability Fuzing, and 4) Enabling Fuze Technologies and Common Architecture.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Hard Target Fuzing ***Description:*** The Hard Target Fuzing challenges are grouped into three Technology Areas. First, improved modeling and simulation capabilities provide the validated computational tools necessary for hard target applications. Second, basic phenomenology and understanding of the Fuze Environment is the science-based endeavor of providing the test equipment, instrumentation, and analysis techniques for experimentation and data gathering necessary for next generation fuzing. Third, hard target survivable fuze components are developed to increase the effectiveness of facility denial munitions by improving the prediction tools and testing methodologies to evaluate the survivability and functionality of legacy and future fuzes. Development of these technologies will enable next generation boosted and hypersonic penetrators to execute missions against hardened and deeply buried targets. ***FY 2018 Plans:*** - Demonstrate survivability and functionality of a High G shock harden fuze firing switch for use in extreme high G environments. - Complete development of improve layer discrimination and void detection sensor and algorithms to more accurately and reliably detect and classify complex hardened targets. ***FY 2019 Plans:*** - Develop fully programmable miniature data recorders for embedded fuzing that can survive extreme hard target fuzing environments.	1.311	1.417	1.417

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 301 / *Enabling Fuze Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Develop and demonstrate methods to accurately replicate high G loading on fuzing components and transition to the DoD and Industry fuze community. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.			
Title: Tailorable Effects Fuzing ***Description:*** Develop fuzing for tailorable effects weapons that encompasses the ability to selectively vary the output of the weapon (Dial-a-Yield) and/or the ability to generate selectable effects (e.g., directed blast, fragmentation). Develop initiation and multi-point technologies; electronic safe and arm based multi-point initiators for tunable output – scalable yield warheads; MicroElectro-Mechanical Systems (MEMS) based multi-point initiators for tunable output/scalable yield warheads; and smart fuzing for tailorable effects weapons. These technologies will enable weapons that can effectively defeat a variety of targets while minimizing unintentional collateral effects. ***FY 2018 Plans:*** - Conduct testing of 10,000+ G survivable multipoint fuze prototype hardware that offer warhead tailorable effects capabilities. - Demonstrate and transition to Industry, a reduced size integrated High Voltage switch technology to fit in commercially available Exploding Foil Initiators (EFI) in a variety of package sizes. ***FY 2019 Plans:*** - Develop technologies for efficient/novel generation of firing energy for multi-point fuze systems. - Develop fuzing components precision timing between initiation of multi-points and of energetic reactions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.	1.564	1.684	1.684
Title: High Reliability Fuzing ***Description:*** Develop high reliability fuzing architectures, fuzing components, and unexploded ordnance (UXO) reduction features. This program's fuzing technologies are critical to enable the next generation of cluster munitions to achieve the required greater than 99 percent reliability. Evolving DoD emphasis on increased weapon system reliability is driving the need to consider new and novel approaches for achieving increased fuze reliability while maintaining or enhancing fuze design safety. DoD policy, higher weapon reliability expectations and harsher weapon system operational requirements are dictating the need for higher fuze reliability than available using current technologies. ***FY 2018 Plans:*** - Demonstrate miniature fuze device safety mechanisms for reduced UXO (unexploded ordnance) and increased reliability.	1.663	1.814	1.772

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 301 / *Enabling Fuze Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Demonstrate a fuze electrical distribution system in an area effect munition that will transfer all necessary power and data signals while maintaining required mechanical ruggedness and minimizing disruption to the munition expulsion event. ***FY 2019 Plans:*** - Develop quantification margin and performance methodologies to enable accurate reliability assessment of fuzing explosive trains. - Demonstrate area-effects weapon fuzing subsystem and system-level prototypes and systems in both laboratory and field environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase of FY2019 funding will allow enabling technology development required for high reliability cluster munitions replacement applications.			
Title: Enabling Fuze Technologies ***Description:*** Develop common/modular fuze architectures; innovative fuze component technologies; sensors; next generation fuze setting capability, tools, and modeling; and fuzing power sources. These fuzing technologies will provide smaller, more cost effective solutions while meeting or exceeding the performance of existing technologies. Development of these technologies will enable future weapon applications to be more mission adaptive and smaller along with improve target detection capabilities. ***FY 2018 Plans:*** - Demonstrate a prototype wireless system to provide power and data transfer to aerial rockets and small guided munitions for use on US Army rotary aircraft. - Demonstrate autonomously Height of Burst (HOB) and target classification sensing system for enhanced area effects munition lethality. ***FY 2019 Plans:*** - Demonstrate miniaturized, low power, target detection device technologies in area-effect weapon simulated target environment testing. - Develop miniature thermal battery technology to yield fast rise time and high power density required for small munitions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change.	1.561	1.673	1.673
Accomplishments/Planned Programs Subtotals	6.099	6.588	6.546

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603000D8Z / *Joint Munitions Advanced Technology*	**Project (Number/Name)** 301 / *Enabling Fuze Advanced Technology*

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• 0602000D8Z P204: *BA2 Enabling Fuze Technology*	5.746	6.201	6.263	-	6.263	6.327	6.431	6.532	6.655	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

1) Transition of technologies developed by the Program are tracked and documented by technology maturity.
2) Fuze Area Technology Groups (FATG) Technology Roadmaps are prepared, evaluated, and analyzed by Joint Fuze Technology Program (JFTP) management and technical staff.
3) Chairman's Annual Assessments for each FATG are critically reviewed by the Technology Assessment Group and Technology Advisory Committee to ensure the JFTP is strategic focused and strong transitions into weapons and industry are taking place.
4) Project progress toward goals and milestones is assessed at each FATG meeting.
5) Annual technical reports and papers are tracked and documented for the Program.
6) Technology Transition Agreements are in place with Munition programs.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603122D8Z / *Combating Terrorism Technology Support*

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	526.241	113.366	101.230	125.271	25.000	150.271	75.517	76.766	78.379	79.275	Continuing	Continuing
484: *Combating Terrorism Technology Support (CTTS)*	526.241	113.366	101.230	125.271	25.000	150.271	75.517	76.766	78.379	79.275	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Combating Terrorism Technical Support (CTTS) program identifies capabilities to combat terrorism and irregular adversaries and delivers these capabilities to U.S. Defense and interagency users, as well as international partners through rapid research and development, advanced studies, and technical innovation. CTTS is expanding its partnerships with other Defense rapid development and acquisition organizations to leverage their expertise and prevent duplication as it tries to expedite and transition new and innovative capabilities for Defense and interagency users.

CTTS major area of emphasis during FY18 and FY19 will be projects to Counter-ISIL. Projects are distributed among 10 mission categories, in line with the interagency Technical Support Working Group (TSWG): Advanced Analytic Capabilities; Chemical, Biological, Radiological, Nuclear, and Explosives; Improvised Device Defeat/ Explosives Countermeasures; Investigative and Forensic Science; Irregular Warfare and Evolving Threats; Personnel Protection; Physical Security; Surveillance, Collection, and Operations Support; Tactical Operations Support; and Training Technology Development.

Specific CTTS areas of emphasis in FY18 and FY19 include Counter-tunnel, Countering-sUAVs, improving digital operations at the tactical level, increasing lethality of small weapons and ammunition, and addressing threats to commercial aviation. The CTTS program is a diverse, advanced technology development effort that capitalizes on interagency and international participation to demonstrate the utility and effectiveness of technology when applied to combating terrorism requirements. It includes technology capability development, proof-of-concept demonstrations in field applications, and coordination to transition from development to operational use. CTTS manages approximately 250 individual projects in support of Defense, federal, state, local, and international customers and partners.

The CTTS program justified in the R-2 exhibit identifies the projects fully or partially funded by Congressional appropriations for the CTTS program. However, the Combating Terrorism Technical Support also develops technology and provides support using external funds provided by other DoD and other federal departments and international partnerships. These projects and support activities are not necessarily reflected in this justification R-2; but the number of activities do reflect positively on the trust and competence that CTTSO has earned throughout the Department and interagency to rapidly conduct critical RDT&E and provide innovative products.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	73.002	101.230	79.902	-	79.902
Current President's Budget	113.366	101.230	125.271	25.000	150.271
Total Adjustments	40.364	0.000	45.369	25.000	70.369
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	42.500	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• General Provisions (FFRDC) Reduction	-0.127	-	-	-	-
• Internal Adjustment - Funds realigned to O&M	-	-	-4.631	-	-4.631
• OCO Request	-	-	0.000	25.000	25.000
• Internal Adjustment	-2.009	-	50.000	-	50.000

Change Summary Explanation

FY 2017 Additional funds received from Congress for the Anti-Tunnel project under Physical Security.
FY 2017 Reductions were in support of Departmental efficiencies and economic assumptions.
FY 2018 - The Department added additional OCO funds to support the Anti-Tunnel project under Physical Security
FY 2019 - The budget was reduced to fiscal constraints and higher priorities within the Department.
FY 2019 OCO request of 25.000 million
FY 2019 The budget was increased for small unmanned aerial system

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Advanced Analytic Capabilities (AAC) ***Description:*** The Advanced Analytic Capabilities (AAC) Subgroup's objective is to develop and deploy integrated analytic capabilities; enabling Commanders, Warfighters, and Mission Partners to share information and make better/faster decisions at the Strategic, Operational, and Tactical levels. AAC projects improve sense-making, decision-making, and data management across a range of mission areas. ***FY 2018 Plans:***	5.054	5.384	5.316	-	5.316

C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Complete the development of an enhanced Critical Thinking Tool that supports the application of evidence-based reasoning for intelligence questions and captures analytic problem-solving approaches. Complete enhancement of the Model Enabled Analysis, Design, and Execution (MEADE) system to include the Military Decision-making Process (MDMP) by identifying and assessing indirect strategies as well as developing response options against associated types of Gray Zone conflicts. Complete development, integration, evaluation, and field testing of Operate to Know (OtK) CONOPS and tools to establish a capability that streamlines multi-modal situational awareness across the spectrum of military operations in emergent theatres of operation. Complete development of a machine learning lab to predict location of relevant assets. Continue development of new capabilities for mission planning and battle management using advanced geographic information systems (GIS) tools on Android based platforms; specifically, the capability to augment geographic information in the field. Continue development of an ability to extract images from the field and make them useable for digital processing using Optical Character Recognition (OCR) processing so that the images can be used in commercial Arabic translation software. Initiate drone based analytics for in-field mission planning support. Initiate development and apply a deterministic open source information prototype that uses current anticipatory analytic approaches to enable forecasting over three to five years to better forecast and project geopolitical turmoil that will drive future Title 10 requirements. Initiate testing of a hardware/software solution that supports two-way intelligence and combat information data flows, in near real-time, between command elements, deployed sensors/collectors, and individual warfighters in both low latency/high bandwidth and high latency/low bandwidth environments with a man-portable form factor. Initiate use of state of the art machine learning predictive data mining tool to detect anomalous activities for C-WMD proliferation. Initiate development of new supercomputer chip applications that can be used for complex calculations, be forward deployed, hosted locally with concealment to facilitate increased targeting, enemy situational awareness, and that can support increased trans-regional understanding of transnational extremist group threat networks. ***FY 2019 Base Plans:*** Complete development of new capabilities for mission planning and battle management using advanced geographic information systems (GIS) tools on Android based platforms; specifically, the capability to augment geographic information in the field. Complete development of an ability to extract images from the field and make them useable for digital processing using Optical Character Recognition (OCR) processing so that the images can be used in commercial Arabic translation software. Complete testing and deployment of a hardware/software solution that supports two-way intelligence and combat information data flows, in near real-time, between command elements, deployed sensors/collectors, and individual warfighters in both low latency/high bandwidth and high latency/low bandwidth environments with a man-portable form factor. Complete use of state					

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603122D8Z / *Combating Terrorism Technology Support*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
of the art machine learning predictive data mining tool to detect anomalous activities for C-WMD proliferation. Continue drone based analytics for in-field mission planning support. Continue development of a deterministic open source information prototype that uses current anticipatory analytic approaches to enable forecasting over three to five years to better forecast and project geopolitical turmoil that will drive future Title 10 requirements. Continue development of new supercomputer chips that can be used for complex calculations to facilitate increased targeting, enemy situational awareness, and that can support increased trans-regional understanding of transnational extremist group threat networks. Continue development for new supercomputer chips that can be used for complex calculations, be forward deployed , hosted locally with concealment to facilitate increased targeting, enemy situational awareness, and that can support increased trans-regional understanding of transnational extremist group threat networks. Initiate Cognitive Sensing capabilities that will develop an understanding of an operational area, the local dynamics, and identify the disruptive trends that could affect that environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2018 Additional funds received in support of the Anti-Tunnel project under Physical Security. Funding for FY 2019 will be budgeted in OCO.					
Title: CHEMICAL, BIOLOGICAL, RADIOLOGICAL, NUCLEAR, AND EXPLOSIVES (CBRNE) ***Description:*** The CBRNE subgroup's objective is to improve defense capabilities to meet tomorrow's CBRNE threats. To meet this objective, the subgroup focuses on rapid research, development, test and evaluation on threat characterization; materials attribution; personal protective equipment; detection of CBRNE materials at trace and bulk levels at point, proximity and stand-off distances; development of information resources and decision support tools to assist response elements with risk-based decision making; and consequence management for post-event activities. ***FY 2018 Plans:*** Complete development of next generation evidence packaging for the safe transport of CBRN materials. Complete evaluation of potential methods of production of threat materials, and identify key indicators and warnings for response personnel. Complete a report on integrated lightweight inhalation hazard detection system capable of signaling a combination unite respirator (CUR) switching- mechanism to change operating modes of a CUR between filtered air and supplied air. Complete development of a low profile tactical SCBA to allow for working in confined spaces, tunnels, and similar access denied environments while providing high quality breathing air. Complete modification of currently fielded ion mobility spectroscopy systems to expand the list of threats detectable to include compounds from emerging military explosives and compounds used in gun powder	8.984	9.575	9.455	-	9.455

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
formulations. Complete assessment of novel genomic sequencing standards for forensics DNA metagenomics. Complete development of a next generation sequencing technology for potential applications in field deployed laboratories. Complete development of a test bed for the evaluation of cargo for contraband including special nuclear materials, explosives, drugs, and other potential materials of interest, utilizing muon tomography and electron stopping. Complete development of a research and development test bed for the evaluation of high volume explosive sampling devices with a focus on cargo/container screening. Complete development of assessment tools and criteria to properly rank and qualify commercial cooling systems to use with CBRNE PPE. Complete development of a risk-based decision support model for skin decontamination in the case of dermal exposures to CWAs. Complete the systematic evaluation of gas forming reactions that could be used in improvised chemical devices. Complete field evaluations and certify a ruggedized garment which provides NFPA 1994 Class 3 and NFPA 1992 protection. Complete development of a modular computer/web-based training package for hand-held explosive detection technologies. Complete NIOSH certification of a new CB protective mask capable of interoperability with tactical equipment for use in tactical environments. Complete NIOSH certification of a 15-min CBRN protection escape hood capable of fitting in the pocket of a suit jacket that also passes the flammability, heat resistance and CO protection requirements for a combination CBRN/CO capability. Complete field testing of wireless communications that provide the ability to communicate without breaching the CBRN suit integrity or requiring an electrical pass-through. Complete testing new methods to more effectively and efficiently collect nanogram quantities of commercial, military, and homemade explosives that are present near improvised explosive devices. Complete development of new hardware and software solutions for a broad range of popular handheld detectors, enabling the real-time connectivity of handheld detectors from remote sites to a central location utilizing the First Responder Sensor Protocol. Complete CBRN respirator testing against additional TICs representative of the current threats encountered. Complete certification of multiple use biological PPE to NFPA 1999, Standards on Protective Clothing for Emergency Medical Operations, protection, and NFPA 1994, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, Class 4. Continue source term development for urban dispersion models to improve the ability to characterize deposition patterns in realistic RDD events. Continue best practices for clean-up procedures for contaminated areas after an RDD event. Continue testing and evaluation of a next generation sensors for use in trace, bulk, proximity, and stand-off detection of explosives-based threats. Continue evaluation of enhanced sampling materials and systems for CBRNE threats. Continue support of the Quadrilateral Group on CBR Counterterrorism. Continue development of an explosive trace detector with a limit of detection less than ten picograms for military and common homemade explosives. Initiate development of a hyperspectral rapid, large area survey instrument that guides activities ranging from contaminant avoidance to decontamination. Initiate the development of cheap, disposable multi agent detection paper (MADP) for					

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
the rapid, selective, and low cost detection of H, G, and V chemical warfare agents. The MADPs shall be able to detect HD, HN, GA, GB, GD, GF, VX, VR, and VS. Initiate the development of a novel, innovative non-encapsulating NFPA 1994 Class 1 protective ensemble that will provide Class 1 protection in a low-profile, tactical ensemble. Initiate the development of a decontamination solution that can be used on skin and wounds and effectively decontaminate chemical and biological warfare agents. Initiate development of a low-cost detect-to-identify wearable sensing technology to inform chemical-specialist first responders and warfighters of the presence of a broad range of TIC and CWA vapors. Initiate efforts to enhance mitigation techniques for threat releases in transportation platforms. ***FY 2019 Base Plans:*** Complete source term development for urban dispersion models to improve the ability to characterize deposition patterns in realistic RDD events. Complete best practices for clean-up procedures for contaminated areas after an RDD event. Complete testing and evaluation of a next generation sensors for use in trace, bulk, proximity, and stand-off detection of explosives-based threats. Complete evaluation of enhanced sampling materials and systems for CBRNE threats. Complete support of the Quadrilateral Group on CBR Counterterrorism. Complete development of an explosive trace detector with a limit of detection less than ten picograms for military and common homemade explosives. Complete development of a hyperspectral rapid, large area survey instrument that guides activities ranging from contaminant avoidance to decontamination. Complete the development of cheap, disposable multi agent detection paper (MADP) for the rapid, selective, and low cost detection of H, G, and V chemical warfare agents. The MADPs shall be able to detect HD, HN, GA, GB, GD, GF, VX, VR, and VS. Complete the development of a novel, innovative non-encapsulating NFPA 1994 Class 1 protective ensemble that will provide Class 1 protection in a low-profile, tactical ensemble. Complete the development of a decontamination solution that can be used on skin and wounds and effectively decontaminate chemical and biological warfare agents. Continue development of a low-cost detect-to-identify wearable sensing technology to inform chemical-specialist first responders and warfighters of the presence of a broad range of TIC and CWA vapors. Continue efforts to enhance mitigation techniques for threat releases in transportation platforms. Initiate synthetic biology efforts that encompass biotechnology, nanotechnology, genomics, medicine, computing, microbiology, and/or engineering. Initiate efforts to better understand microbial associations within complex microbial communities. Initiate an online database containing feedback on field performance of CBRNE detector systems, test data on a detector performance, and where or who can be contacted to receive a report depending on the data's sensitivity. Initiate a man-portable systems that can reliably detect explosives through continuous monitoring of the gas phase. Initiate a lightweight, portable passive system for the detection of biological warfare agents. Initiate a field dispersible, short-lived, alpha radiation training aid for a variety of training application.					

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Initiate a container capable of retaining shelf life and efficacy when mask and filter are assembled together. Initiate an online database to automatically ingest open source information to identify and characterize chemical and biological facilities worldwide. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Minor changes and reductions were in support of Departmental efficiencies.					
Title: IMPROVISED DEVICE DEFEAT (IDD) ***Description:*** The IDD/EC Subgroup's objective is to deliver capabilities to defeat or neutralize the continuum of terrorist improvised weapons and explosive devices. IDD/EC improves the operational capabilities of the bomb disposal community, consisting of military Explosive Ordnance Disposal (EOD), and federal, state, and local bomb squads, by developing and delivering advanced tools and technologies, and decision support information to defeat improvised terrorist devices. The IDD/EC Subgroup identifies and prioritizes multi-agency end-user requirements in collaboration with military units, and federal, state, and local agencies. IDD/EC actively works with vendors and end-users to deliver advanced prototype systems that provide greater efficiency and increased safety for bomb technicians who investigate, access, evaluate, and if needed, render safe or dispose of suspect devices. All development efforts undertaken are in support Presidential Policy Directive 17 (PPD-17), Countering Improvised Explosive Devices, and the National Bomb Squad Commanders Advisory Board (NBSCAB) National Strategic Plan. ***FY 2018 Plans:*** Complete an East Coast-based technology requirement gathering capability exercise (TRG CAPEX) to develop and test advanced skills to maneuver hazardous duty robots in challenging, real-world scenarios. Complete development of a lightweight IED protective suit and ballistic helmet to allow increased freedom of movement during counter-IED operations. Complete development of power efficient advanced communications ECM techniques that are fully capable of defeating the environmentally adaptive communications capabilities embedded in most advanced wireless systems and networks. Complete research of methods for electromagnetic and electrostatic discharge mechanisms for counter-IED applications in support of directed energy neutralize capabilities. Complete development of an HME neutralization field reference for use by military EOD and public safety bomb technicians. Complete development of common test standards and assessment methods for the full spectrum of EOD disruptors to facilitate the exchange of reliable data. Complete development of a device defeat application that allows bomb technicians to select disruption tools based on automated X-ray diagnostics. Complete development of a robot-mounted X-ray Backscatter system for VBIED diagnostics. Complete development of a hands-free bomb suit heads-up display that projects mission and	6.363	7.222	7.131	-	7.131

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
sensor data onto a bomb suit helmet screen. Complete development of a multi-fit inflatable bomb suit helmet liner capable of being retrofitted to the Med-Eng™ EOD 9, EOD 9A, and SRS 5 model helmets. Continue development of a 3D X-ray Imaging System to interrogate a suspected IED and locate critical components. Conduct a workshop that integrates EOD and Public Safety Bomb Technicians with engineers and roboticists to collaboratively design and develop new capabilities for VBIED response. Initiate development of a humanoid robot for use in IED Defeat operations in urban environments. Initiate development of a small, high definition, live-streaming camera that displays images onto a wearable screen or integrates into a bomb suit heads-up display. Initiate development of a mixed-reality visualization system for command post/up-range support that will allow bomb technicians and support personnel to see what is transpiring downrange and assist the bomb technician with on-scene analysis. Initiate the development of an enhanced spatial awareness capability for robotic platforms that can maintain 360-degree awareness of the platform's surrounding environment. Initiate the development of a library of CAD files that can be printed with an inexpensive 3D printer at the bomb squad location or sourced to outside parties for printing. Initiate research to produce customizable energetic tools to disrupt explosive devices in high-risk environments. ***FY 2019 Base Plans:*** Complete development of a 3D X-ray Imaging System to interrogate a suspected IED and locate critical components. Conduct a workshop that integrates EOD and public safety bomb technicians with engineers and roboticists to collaboratively design and develop new capabilities for VBIED response. Continue development of a humanoid robot for use in IED Defeat operations in urban environments. Continue development of a small, high definition, live-streaming camera that displays images onto a wearable screen or integrates into a bomb suit heads-up display. Continue development of a mixed-reality visualization system for command post/up-range support that will allow bomb technicians and support personnel to see what is transpiring downrange and assist the bomb technician with on-scene analysis. Continue the development of an enhanced spatial awareness capability for robotic platforms that can maintain 360-degree awareness of the platform's surrounding environment. Continue the development of a library of CAD files that can be printed with an inexpensive 3D printer at the bomb squad location or sourced to outside parties for printing. Continue research to produce customizable energetic tools to disrupt explosive devices in high risk environments. Initiate development of a smartphone or tablet-based application that will allow bomb technicians to relay IED and IED incident information graphically to fellow bomb technicians in real-time. Initiate development of bomb disposal tools for deployment on, or by, small UAS-based platforms. Initiate development of a searchable library of IED circuits that will allow bomb technicians to quickly compare and identify known IED circuits. Initiate development of a low cost obstruction avoidance and proximity alert system for robotic platforms. Initiate development of an					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
electronic, user-updatable UAS Guidebook that can be used as a quick reference during response operations for identification and analysis of downed UAS platforms. Initiate development of a rapidly mountable backscatter X-ray system for small to medium sized robotic platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental.					
Title: INVESTIGATIVE AND FORENSICS SCIENCE ***Description:*** The IFS subgroup's objective is to advance combating terrorism capabilities in investigative and forensic science. IFS supports joint, interagency, and other partners who apply investigative and forensic science methods, means, or practices to forensic intelligence or investigations. To meet this objective, the subgroup focuses on rapid research, development, test and evaluation of new and advanced technology, equipment, forensic techniques, and investigative tools, as well as development of information resources and on support tools for risk-based decision-making and rapid exploitation of evidence. Projects emphasize rapid and field deoxyribonucleic acid (DNA) analysis, identification of insider threat within agencies, pre-blast and post-blast forensic examination, electronic evidence data acquisition and analysis, sensitive site exploitation, forensic intelligence, and criminalistics. ***FY 2018 Plans:*** Complete the development of latent print lifters based on antigenic reagents that can be used without detection. Complete development of a tool that can search the internet, find data associated with a user name and password and then collect and store the data. Complete development of a forensic tool that can detect handwriting on digitized documents regardless of the language and then extract it for later analysis. Complete development of a new collection device of trace DNA and new procedures to determine more advanced data from it. Complete the development of electronic transmission protocols for fingerprints and palm prints. Complete the research to determine the best credibility assessment techniques and procedures to be used on persons living in the regions around Israel and distribute the results. Continue the development of a handheld device that can document incident scenes, collect fingerprint images, and can make comparisons at the scene with outside databases. Initiate development of an intelligence focused facial recognition system that analyzes streaming or multiplexing images and videos sources of large volumes. Initiate development of an unconstrained face recognition system for intelligence community to process relevant streaming or multiplexed image and video sources that are too labor intensive for manual review due to their volume. Initiate development of an advanced scalable facial recognition system based on the government developed model. Initiate the research and production of a field handbook describing the procedures used by the Five Eyes nations in exploiting	4.420	5.374	5.306	-	5.306

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
tactical and sensitive site for forensic and investigative information. Initiate development of standard protocols, procedures, and best practices for forensic speaker comparison examiners to accomplish their analyses and examinations. Initiate the development of a miniature concealable body worn audio-video transmitter for law enforcement and tactical personnel. Initiate the development of algorithms that increase the accuracy of NCCA's Avatar and thermal imaging credibility assessment systems. Initiate the development of automated methods to convert foreign fingerprint files into US compatible electronic files and anonymous the source. ***FY 2019 Base Plans:*** Complete the development of a handheld device that can document incident scenes, collect fingerprint images, and can make comparisons that scene with outside databases. Complete the development of an intelligence focused facial recognition system that analyzes streaming or multiplexing images and videos sources of large volumes. Complete the development of an unconstrained face recognition system for intelligence community to process relevant streaming or multiplexed image and video sources that are too labor intensive for manual review due to their volume. Complete the development of an advanced scalable facial recognition system based on the government developed model. Complete the research of a field handbook describing the procedures used by the Five Eyes nations in exploiting tactical and sensitive site for forensic and investigative information. Complete the development of standard protocols, procedures, and best practices for forensic speaker comparison examiners to accomplish their analyses and examinations. Complete the development of a miniature concealable body worn audio-video transmitter for law enforcement and tactical personnel. Complete the development of algorithms that increase the accuracy of NCCA's Avatar and thermal imaging credibility assessment systems. Initiate development of DNA collection and analysis procedures usable in sensitive sites and restricted areas without leaving any trace. Initiate the development of an instrument that visualizes fingerprints from a distance using ultraviolet light and does not leave any traces. Initiate development of an application that can search for vehicles in digital files and learn new vehicles from inserted images. Initiate development of an application that can search video files for specified objects through the use of artificial intelligence. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental efficiencies.					
Title: Irregular Warfare and Evolving Threats (IW/ET) ***Description:*** The IW/ET subgroup develops new concepts and capabilities for warfighters and inter-agency partners who are confronting the complexity of the current operational environment, while simultaneously looking outward rather than inward to appropriately size, shape and develop their forces. In accordance with the	6.285	7.199	7.109	-	7.109

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Quadrennial Defense Review's (QDR) emphasis on preparation to defeat adversaries and succeed in a wide range of contingencies, IW/ET will engage in operational assessment, concept development, and independent validation of unique prototype capabilities to identify, confront, and defeat evolving threats. ***FY 2018 Plans:*** Complete the design of a holistic common interagency analytical and planning approach that better identifies capabilities, authorities and funding, links US, Allied and partner nation objectives and builds synergy when conducting partner nation capacity building missions. The analytical and planning approach is available for use in interagency and allied nation training curriculum. Complete the development of a platform to collect and analyze photographs, videos, audio recordings, and general text-based information via precise crowd sourcing techniques. The technical approach will provide the capability to conduct facial, object and ISIL branded content recognition. An Android-based application will also be available that can be customized for a specific region, language, and purpose to use for crowd source media collection. Upon completion, the project will immediately enhance the ability of information communicators to collect, search, retrieve, view and analyze photos, audio, and video for use. Complete the transition of the Nightingale effort to deploy digital workflow, approval, and archival processes in support of the CVE mission. This project will provide enhanced coordination, information sharing, and messaging capabilities in support of countering violent extremism. Complete the Western Hemisphere Illicit Pathways effort implementing advanced information exchange tools and training to help build partner nation collaborative capacity among critical U.S. southern borders and approaches. Complete OCONUS operational test and evaluation (OT&E) to provide forward deployed units with access to PAINT. This project will provide teams operating in high threat areas with real-time indications and warnings for blue force protection using social media and other publicly available information (PAI). OT&E will conclude in June 2018. Complete development of an improved capability to conduct multi-layered analysis of the Information Environment using publicly available information and display relevant data and product views in a Common Operating Picture to facilitate Phase 0 planning of Information Environment shaping activities to effectively compete in the environment against state and non-state actors. Complete report that defines the information environment in 2025, outline potential capability gaps, and describe necessary actions in order to gain and maintain information dominance. In addition, this effort will explore information-related capabilities of defense agencies, emerging technologies, and will recommend implementation considerations based on current budget concerns. Upon completion, this project will help prepare the USG for evolving challenges in hybrid-warfare. Complete development of a capability to simultaneously engage populations across numerous modalities such as social media, web, voice, SMS, MMS, and paper-to-digital, in order to reach disconnected populations around the globe. This effort will enable wide-scale two-way communications in a variety of geopolitical environments,					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
to include those areas with and without internet connectivity. Complete development of a database containing relevant foreign criminal statutes/regulations translated into English and searchable against identified behaviors/activities. This will enable users to compare and search for relevant foreign criminal statutes/regulations as well as the willingness/capability of partner nations to take action against identified threat networks. While this approach will initially focus on violent extremist organizations and their supporting networks, it can be applied across a wide-range of non-State, unconventional, and hybrid threats, to include counter-proliferation networks and transnational criminal organizations. This project will help operationalize law as another non-kinetic tool for commanders. Complete the development and test of an exportable information operations capability that legitimate governments' can use to counter violent extremist messaging. Conduct testing and evaluation by delivering training and periodic evaluation through the use of mobile advise and assist training teams. Continue a Remote Advise and Assist (RAA) project to examine conditions that would lead to successful RAA operations in a full spectrum environment and then develop and field advanced RAA prototypes in order to test the ability of advisors to continue mentoring partners remotely. By having a robust RAA capability, advisors will be able to significantly enhance time with their partners when physical access is severely restricted. By being able to advise partners in a real time operational environment, the time-period needed to enhance that partner's capacity can be significantly reduced. Observations will examine how to advance virtual communications between advisors and partners during operations. Continue the development of a tool to support decision makers managing digital operations with some form of predictive advice as to how people will respond to a choice of different types of interventions. In this way, decision-making will be improved not only for planning purposes but also for the development of capability underpinned by a behavioral science evidence base. Continue an effort to manage, enhance, and maintain a SUNet enterprise system that allows the user the ability to detect, monitor, understand, and act in the information environment through mission specific enclaves (partitioned mission or function information cells). Initiate and complete a simplified Full Spectrum Remote Advise and Assist (FS-RAA) project to simplify current RAA prototypes in order to test the ability of advisors to continue mentoring poorly educated and minimally vetted partners. By having a simplified FS-RAA capability, advisors will be able to enhance time with their partners when physical access is severely restricted. By being able to advise poorly educated and minimally vetted partners in a real time operational environment, the time period needed to enhance that partner's capacity can be significantly reduced while still protecting advanced tactics, techniques and procedures reserved for closely vetted partners. ***FY 2019 Base Plans:*** Complete a Remote Advise and Assist (RAA) project to examine conditions that would lead to successful RAA operations in a full spectrum environment and then develop and field advanced RAA prototypes in order to test					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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Title: PERSONNEL PROTECTION ***Description:*** The Personnel Protection Subgroup's objective is to develop new equipment, reference tools, and standards to improve the protection of personnel. Projects focus on putting innovative tools such as automated information management systems, communication devices, tagging, tracking and locating devices, mobile surveillance systems, as well as personal and vehicle protection equipment in the hands of personnel.	6.895	8.588	16.479	-	16.479

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C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
FY 2018 Plans: Complete development of systems to enhance situational awareness, intelligence collection capabilities, and personnel recovery efforts. Complete development of counter unmanned aerial vehicle capabilities. Complete development of a novel material for ballistic and blast protection that utilizes fiber optics to enable visibility with opaque armor. Complete development of a stand standalone personal armor plate for high power, armor piercing projectile threats using advanced materials. Complete development of a helmet system to protect against common high power rifle projectile threats. Complete the development of a test apparatus that serves to measure dynamic and static events during and after the course of a ballistic impact. Complete development of a small lightweight wearable device that securely transmits biometric and geolocation data to a common operating picture. Complete development of a mobile sensor suite that can detect subsonic and supersonic rounds that are fired at a convoy and display the round's origin, heading and range on a real time map to provide situational awareness to the operator. Continue development of biomarker identification for brain injury using magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) to monitor neurochemical biomarkers for post-traumatic stress disorder and mild traumatic brain injury. Continue development of a man packable system that reduces or eliminates the radar, electronic, thermal, infrared, visual or acoustic signatures of a dismounted soldier. Continue the development of a multi-modal system to detect, identify and mitigate unmanned aerial threats to tactile vehicles and other mobile platforms in terrestrial and maritime environments. Initiate development of standalone armor plates to defeat the 7.62 X 39mm, 124 grain, mild steel core (MSC) projectile. Initiate development of an air deployable unmanned aerial system that is capable of dashing ahead of the V-22 and providing at least 8.5 minutes of overhead intelligence, surveillance and reconnaissance (ISR) at the landing zone or drop zone prior to the force arrival. Initiate development of a robust Electromyography (EMG) sensor system comprised of electrodes, sampling electronics and processing electronics capable of integration into a robotic/human augmentation platform. Initiate the development of advanced systems to detect and mitigate unmanned aerial threats using novel detection and mitigation modalities. ***FY 2019 Base Plans:*** Complete development of biomarker identification for brain injury using magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) to monitor neurochemical biomarkers for post-traumatic stress disorder and mild traumatic brain injury. Complete development of a man packable system that reduces or eliminates the radar, electronic, thermal, infrared, visual or acoustic signatures of a dismounted soldier. Complete the development of a multi-modal system to detect, identify and mitigate unmanned aerial threats to tactile vehicles and other mobile platforms in terrestrial and maritime environments. Continue development of standalone armor plates to defeat the 7.62 X 39mm, 124 grain, mild steel core (MSC) projectile. Continue					

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
development of an air deployable unmanned aerial system that is capable of dashing ahead of the V-22 and providing at least 8.5 minutes of overhead intelligence, surveillance and reconnaissance (ISR) at the landing zone or drop zone prior to the force arrival. Continue development of a robust Electromyography (EMG) sensor system comprised of electrodes, sampling electronics and processing electronics capable of integration into a robotic/human augmentation platform. Continue the development of advanced systems to detect and mitigate unmanned aerial threats using novel detection and mitigation modalities. Initiate the investigation of the root causes of poor armor fit among U.S law enforcement agencies. Identify corrective actions and standard procedures to ensure proper fit to body armor users across the anthropometric spectrum of law enforcement professionals. Initiate the development of a vehicle mounted, tethered aerial platform capable of carrying a wide variety of payloads to fill various mission needs. Initiate the development of a test fixture to validate the performance of non-pneumatic limb tourniquets. Initiate the development of a heads up display unit to be integrated into an existing helmet system and provide day and night display of data elements of interest to the operator. Initiate the development of advanced, novel armor materials to provide next generation ballistic personal protection systems to military and law enforcement professionals. CUAS On the Move (MACE)/MAFIA Integration/BEAM, MACE, CORIAN Integration - Develop a system to provide a mobile platform to precisely detect, identify and mitigate sUAS threats; integrate the system into an existing command/control system; and ensure compliance with other systems. Soldier Worn CUAS/Single Node Capability - Develop a system to provide a dismounted squad with the ability to precisely detect, identify and mitigate sUAS threats by reducing the size and increasing the capability of a single node minimal degradation to operational performance. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental efficiencies.					
Title: PHYSICAL SECURITY ***Description:*** Rapidly develop and transition physical security/force protection capabilities and technologies to support forward deployed and domestic first responders, military, interagency, and international partners in the focus areas of Blast Effects and Mitigation; Maritime Security; Screening, Observation, Detection, and Protection; and, Subterranean Activities. Emphasize these technology development efforts primarily at U.S. embassies and consulates, forward operating bases, along the U.S. borders, at mass transportation and commerce nodes, in maritime port and littoral environments, and in support of large scale public venues. ***FY 2018 Plans:*** Complete development of an automatic target recognition system for on-the-move, standoff IED detection. Complete development of an Advanced Diver Data Display System final prototype for combat swimmers.	48.375	31.631	6.547	25.000	31.547

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Complete development and upgrade of a tactical compact aerostat surveillance system for ground and maritime intelligence, surveillance and reconnaissance, as well as communication between non-line-of-sight (NLOS) forces. Complete development of computer modeling and simulation program to determine the smallest booster size needed to initiate detonation of Ammonium Nitrate prill in shipping configuration to determine screening and detection capability needed to prevent the weaponization of fertilizer being transported in public areas. Complete joint work between U.S. and Australia to test, characterize and model a novel propane tank Vehicle Borne Improvised Explosive Device (VBIED) threat. Complete development of a portable and ruggedized body scanner for personnel protection missions based on the existing AIT stationary body scanner system developed by Tek84. Complete development and evaluation of a scanning system able to maneuver independently inside specified geophysical target areas and provide situational awareness. Complete the design and characterization of a test site for testing emerging technologies for unique operational missions. Complete development of a surveillance system with automated 360-degree long range scanning capability (optical radar) to protect the Force in tactical combat outposts. Complete development of a set of guidelines and certifications that can be used by public, private, academic, and government entities to support the qualification of engineers and architects capable of characterizing and mitigating explosive effects. Complete testing on localized responses from facades to quantify the effects of responding components on blast propagation through a new series of controlled explosive tests at the Urban Canyon Test facility. Complete development of a joint multi-disciplinary geophysical survey kit, comprised of distinct tools. Continue construction of a test site in a specific geographic region for testing emerging technologies for unique operational missions. Complete development of a set of handcuffs that are able to withstand specific physical defeat techniques employed by a detained individual or individuals without the appropriate key, while maintaining the basic design and functionality of currently used handcuffs. Complete development of a software tool associated with a comprehensive evaluation of horizontal directional drilling (HDD) equipment that can be used to focus intelligence collection and threat assessments, providing leadership with enhanced situational awareness and directing the allocation of limited resources to areas of highest risk. Complete the design and installation of a novel concept for an underground training and tactical test site in the United States, for training operators and testing and evaluating tactical technologies. Complete development of a larger version of a technology used to block entrances or doorways with time delay and cart for system transport. Continue development of an advanced active diver thermal protection system for long exposure dives, including SEAL Delivery Vehicle (SDV) operations. Continue development of decision aids for first responders and military engineers by testing explosives effects in an urban environment, to include Historic Masonry and frangible front structures. Continue development of a prototype communications system for special missions in specified environments. Continue development of a system for detection of unique geophysical phenomena and testing and evaluation of the prototypes' performance in representative					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
sites. Continue development of a mobile system for stand-off detection and mapping of specified geophysical phenomena using technology developed under previous bilateral tasks. Continue development, integration and T&E of an extended coverage system for novel border protection applications in different terrain/geophysical conditions. Continue development of additional mission capabilities to the Sappheiros unattended ground sensor system to enable deployment, detection and tracking of targets in various geophysical environments. Continue development of a prototype system and concept of operations to detect a particular geophysical phenomenon. Continue development of improved, cost-effective High Power Radio Frequency (HPRF) sources for nonlethal vessel and vehicle stopping that achieve militarily useful effective ranges against fast moving target. Continue development of an algorithm for detecting weapons in baggage that will be integrating into existing baggage x-ray systems. Continue development of a roller door that is forced-entry (FE) resistant and capable of meeting the State Department 15-Minute FE performance criteria. Initiate the testing and evaluation of the use of binary explosives for unique applications in specific environments. Initiate development of a remote activation device for tactical arresting systems designed to stop vehicles over a short distance. Initiate development of an in-depth guide of best practices for rescuing tunnel collapse victims inside OSHA-compliant and non-compliant tunnels to enhance survivability. Initiate development of a novel ship-to-shore fuel transport system in an amphibious towable container that mitigates risk to personnel and fuel loss in the event of an attack. Initiate development of a long-term sensor system incorporated during the tunnel remediation process that will detect tampering, motion, and tunneling activity and provide an alert to a remote monitoring station. Initiate adaptation of a proven land system to a novel type of detection platform. Initiate modification of the Dialogue system to enable communication among a network of multiple users and at longer ranges. Initiate development of a tactical spray-on reinforcement kit for potentially dangerous structures. Initiate development of a self-positioning personnel tracking system. Initiate development of a fast-running ultra-high performance concrete slab model, WAC-U, and improve tools for design, protective use, and vulnerability assessments. Initiate development of a compact, user-friendly tool for measuring the azimuth and range of a below ground structure from above ground that provides the measurements in real-time. Initiate development of a tactical and easy-to-use tool that will enable an operator to see behind obstacles (e.g. brick walls, sandbags, doors, etc.), from a safe distance, in underground confined structures. Initiate development of a new capability for the modeling of tunnel IED effects within the Vulnerability Assessment and Protection Option (VAPO) software tool and for rendering tactical tunnels unusable through predictive blast modeling. ***FY 2019 Base Plans:*** Complete construction of a test site in a specific geographic region for testing emerging technologies for unique operational missions. Complete development of an advanced active diver thermal protection system for long					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
exposure dives, including SEAL Delivery Vehicle (SDV) operations. Complete development of decision aids for first responders and military engineers by testing explosives effects in an urban environment, to include Historic Masonry and frangible front structures. Complete development of a prototype communications system for special missions in specified environments. Complete development of a system for detection of unique geophysical phenomena and testing and evaluation of the prototypes' performance in representative sites. Complete testing and evaluating the integration of proven land-based sensors into a novel platform for conducting advanced geophysical surveys. Complete development of a mobile system for stand-off detection and mapping of specified geophysical phenomena using technology developed under previous bilateral tasks. Complete development, integration and T&E of an extended coverage system for novel border protection applications in different terrain/ geophysical conditions. Complete development of a prototype system and concept of operations based on a particular geophysical phenomenon. Complete the testing and evaluation of the use of binary explosives for unique applications in specific environments. Complete development of a remote activation device for tactical arresting systems designed to stop vehicles over a short distance. Complete development of an algorithm for detecting weapons in baggage that will be integrating into existing baggage x-ray systems. Complete development of a roller door that is forced-entry (FE) resistant and capable of meeting the State Department 15-Minute FE performance criteria. Complete the development of an in-depth guide of best practices for rescuing tunnel collapse victims inside OSHA-compliant and non-compliant tunnels to enhance survivability. Complete development of a long-term sensor system incorporated during the tunnel remediation process that will detect tampering, motion, and tunneling activity and provide an alert to a remote monitoring station. Complete modification of the Dialogue system to enable communication among a network of multiple users and at longer ranges. Continue development of a tactical spray-on reinforcement kit for potentially dangerous structures. Continue development of a self-positioning personnel tracking system. Continue development of additional mission capabilities to the Sappheiros unattended ground sensor system to enable deployment, detection and tracking of targets in various geophysical environments. Continue development of improved, cost-effective High Power Radio Frequency (HPRF) sources for nonlethal vessel and vehicle stopping that achieve militarily useful effective ranges against fast moving targets. Continue development of a novel ship-to-shore fuel transport system in an amphibious towable container that mitigates risk to personnel and fuel loss in the event of an attack. Continue development of adapting a proven land system to a new type of platform detection. Continue development of a fast-running ultra-high performance concrete slab model, WAC-U, and improve tools for design, protective use, and vulnerability assessments. Continue development of a compact, user-friendly tool for measuring the azimuth and range of a below ground structure from above ground that provides the measurements in real-time. Continue development of a tactical and easy-to-use tool that will enable an operator to see behind obstacles (e.g. brick walls, sandbags, doors, etc.), from a safe distance, in underground					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
confined structures. Continue development of a new capability for the modeling of tunnel IED effects within the Vulnerability Assessment and Protection Option (VAPO) software tool and for rendering tactical tunnels unusable through predictive blast modeling. ***FY 2019 OCO Plans:*** Funding request supports the Anti-Tunnel project.. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY 2018 the Department added additional OCO funds to support the Anti-Tunnel project. In FY 2019 funding in the amount of $25.000 will be requested in OCO.					
Title: SURVEILLANCE, COLLECTION AND OPERATIONS SUPPORT ***Description:*** Identify high-priority user requirements and special technology initiatives focused primarily on countering terrorism through offensive operations. Enhance US intelligence capabilities to conduct retaliatory or preemptive operations and reduce the capabilities and support available to terrorists. ***FY 2018 Plans:*** Complete the critical design, development, and initial production of the CALYPSO RFIC and initial transceiver devices with integrated CALYPSO chips resulting from the Atlas Enhancement Study. Complete Classified Technical Collection Project. Complete Madonna Classified Social Media Project. Complete Scorpion Classified Telematics Project and delivery of tools and training. Complete Integration of voice identification technologies onto the ROVER signal intercepts capability. The effort shall support integration and correlation of voice capabilities as well as future, optional features including analysis of social media and activity pattern analysis. Complete development of a Biometric System for identifying Cardiological Signatures. Complete developmental effort of a small, stand-alone tracking device capable of obtaining position location information (PLI) in the presence of high powered jamming/spoofing or in areas of weak GPS signals. Complete project that leverages of assets and capabilities to support United States and United Kingdom's research and development efforts in the areas of audio, video, image and text processing from (primarily, but not constrained to) open data sources. Complete development of an automated software-based tool that will extract face and hand related data from video streams and fuse the results to present the strongest possible measure of identity from available data. This effort shall provide a functional platform that can be expanded to include other biometric factors found in video such as voice, gait, movements and gestures. Complete Dragonfly Classified Technical Collection Project. Complete development to integrate the capabilities necessary to receive and process the Iridium GDB service into a custom version of Qualcomm's SirfstarVXP, an application specific integrated circuit (ASIC). Continue	9.076	9.535	9.415	-	9.415

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C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
development of new or improved technologies pertaining to non-standard, secure communications. Continue Cattledog Classified Surveillance Project. Continue development to deliver novel and high-performance noise reduction and speaker TTL software, based on cochlear and auditory cortex models. The effort shall support the delivery and integration of two software packages to support military operations and to enhance DOD capabilities. The technologies must provide near real-time situational awareness of incoming signals, filtering speakers, messages, languages, and location. Continue development of High Altitude Pseudo Satellite payloads in support of the Coalition Warfare Joint Capabilities Demonstration to develop the Pseudo Synthetic Aperture Radar for airborne persistent surveillance systems. Continue development and demonstration of a low profile tactical radio system with optimized performance. The system will enable ready exchange of information between mobile tactical users in a form factor that provides the flexibility to customize the configuration and achieve communications without or in an area with degraded infrastructure. Continue project to support information sharing and testing of newly developed EW capabilities with the United Kingdom. Initiate development of a single compact, gimbaled next generation Hyperspectral Imagery (HSI) aerial sensor in both SWIR and LWIR wavebands and provide industry standard data outputs. Initiate development of a KA band small form factor electronically steerable array antenna system for maritime and mobile operations. Initiate Othello Classified Technical Collection Project. Initiate development of the Carthage Classified Project to develop an Emergency Notification and Tracking communications capability. Initiate development of Cajamarca, a classified cyber enabled capability. Initiate development of project Crossfire, a classified special communications and technical collection capability. ***FY 2019 Base Plans:*** Complete development of new or improved technologies pertaining to non-standard, secure communications. Complete Cattledog Classified Surveillance Project. Complete development to deliver novel and high-performance noise reduction and speaker TTL software, based on cochlear and auditory cortex models. The effort shall support the delivery and integration of two software packages to support military operations and to enhance DOD capabilities. The technologies must provide near real-time situational awareness of incoming signals, filtering speakers, messages, languages, and location. Complete development and demonstration of a low profile tactical radio system with optimized performance. The system will enable ready exchange of information between mobile tactical users in a form factor that provides the flexibility to customize the configuration and achieve communications without or in an area with degraded infrastructure. Complete project to support information sharing and testing of newly developed EW capabilities with the United Kingdom. Complete development of a KA band small form factor electronically steerable array antenna system for maritime and mobile operations. Complete Othello Classified Technical Collection Project.					

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Complete development of the Carthage classified project to develop an Emergency Notification and Tracking communications capability. Continue spiral development of the CALYPSO RFIC and update to the initial transceiver devices with integrated CALYPSO chips providing an enhanced programmable waveform integration capability. Continue development of High Altitude Pseudo Satellite payloads in support of the Coalition Warfare Joint Capabilities Demonstration to develop the Pseudo Synthetic Aperture Radar for airborne persistent surveillance systems. Continue development of a single compact, gimbaled next generation Hyperspectral Imagery (HSI) aerial sensor in both SWIR and LWIR wavebands and provide industry standard data outputs. Continue development of Cajamarca, a classified cyber enabled capability. Continue development of project Crossfire, a classified special communications and technical collection capability. Initiate classified feasibility assessment to design and develop a new Cube Satellite Communications System. Initiate classified project to develop a new Personal Electronic Device Secured Note taking application. Initiate development of a new miniaturized Ultra High Frequency Band antenna or family of antennas. Initiate classified project to develop a specialized antenna system. Initiate classified project to develop wave form identification system. Initiate classified feasibility assessment resulting in an initial design for a new Mesh Enabled Communication System. Initiate classified project to develop a Media Exploitation capability. Initiate classified project to develop a Technical Assessment Capability. Initiate classified project to develop Encrypt and Wipe application. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental efficiencies and economic assumptions.					
Title: TACTICAL OPERATIONS SUPPORT ***Description:*** The Tactical Operations Support subgroup's mission is to execute rapid research and development projects that enhance capabilities of DoD and Interagency special operations tactical teams engaged in finding, fixing, and finishing terrorists. This includes support to state and local law enforcement agencies to combat domestic terrorism. The development focus is enabling small tactical units by providing state of the art overmatch capabilities in: Offensive Systems; Unconventional Warfare, Counter-Insurgency Support; Tactical Communications; Tactical Reconnaissance, Surveillance, and Target Acquisition Systems; Specialized Infiltration, Access and Exfiltration Systems; and Survivability Systems. ***FY 2018 Plans:*** Complete spiral development to improve form factor, interoperability, and battery life of a state-of-the-art amplified transceiver speaker unit to work with a number of military and commercial radio devices. Complete development of an augmented reality navigation system capability that fuses and overlays a tablet camera's live footage, navigation instructions, and targeting information for an operator to utilize while operating a	13.047	10.505	52.373	-	52.373

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
vehicle. Complete development and delivery of a modular multi-ability rapidly reconfigurable hand launched small unmanned aircraft system with a common controller that is capable of being re-configured in the field for mission specific tasks. Complete development of a 7.62x51mm subsonic round optimized to address powder sensitivity issues in order to improve consistency, range, and accuracy. Complete development and delivery of a tactical communications capability that provides small tactical teams the ability to utilize cutting edge software applications and smartphone hardware over an untrusted host-nation cellular/internet infrastructure that also includes integration with the Android Tactical Assault Kit (ATAK) and secure forward operational logistics. Complete development and delivery of a multispectral augmented visually enhanced reality imaging capability that provides a significant advantage for long-range target acquisition in challenging environments. Complete development and delivery of a maritime canister launched small unmanned aerial system for amphibious and maritime operations requiring overhead aerial ISR capabilities. Complete development and delivery of a next-generation small unmanned aircraft system stabilized gimbal that integrates laser target designation technologies. Complete development of an increased field of view night vision device for Special Operations Forces (SOF). Complete development of a capability to self-geolocate without causing an RF signature and without relying on GPS capabilities. Complete test and evaluation of next generation tooth acoustic communications system for low-profile operations. Continue development of an Air to Surface Employment Kit (A2SEEK), for the already developed Micro Weather Sensor (MWS), to be packaged into a complete system that will be air dropped out of military aircraft to support operators and C2 elements to receive sensed weather elements and formulate aviation reports in deep battlespace or denied areas. Continue development of a man-portable (dismounted/static), on-the-move (vehicle mounted), and kinetic kill anti-drone system kit that is capable of detection, tracking, identification, and defeating a small Unmanned Aircraft System (sUAS). Continue development of an accurized 120mm mortar system with an advanced targeting system for installation and employment on a 5-ton Medium Tactical Vehicle (MTV) capable of lethal target engagement from a short halt out to 7 kilometers. Continue testing and optimization of barrel length, rifling twist rate, and suppression of the .300 Blackout rifle platform in conjunction with an underwater supercavitating ammunition. Continue spiral development of a next generation Lightweight Medium Machine Gun (LWMMG) and polymer .338 Norma Magnum ammunition to give operators a distinct advantage in both the extended and close-in fight and be able to transition rapidly from mounted operations to dismounted operations. Initiate development of a High Frequency (HF) radio integrated into a cellular phone for use in low-profile operations. Initiate development of a new ballistic algorithm, projectile drag coefficient, and weapon system for lethal target engagement beyond 2,500 meters. ***FY 2019 Base Plans:***					

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Complete development of an Air to Surface Employment Kit (A2SEEK), for the already developed Micro Weather Sensor (MWS), to be packaged into a complete system that will be air dropped out of military aircraft to support operators and C2 elements to receive sensed weather elements and formulate aviation reports in deep battlespace or denied areas. Complete development of a man-portable (dismounted/static), on-the-move (vehicle mounted), and kinetic kill anti-drone system kit that is capable of detection, tracking, identification, and defeating a small Unmanned Aircraft System (sUAS). Complete development of an accurized 120mm mortar system with an advanced targeting system for installation and employment on a 5-ton Medium Tactical Vehicle (MTV) capable of lethal target engagement from a short halt out to 7 kilometers. Complete testing and optimization of barrel length, rifling twist rate, and suppression of the .300 Blackout rifle platform in conjunction with an underwater supercavitating ammunition. Complete spiral development of a next generation Lightweight Medium Machine Gun (LWMMG) and polymer .338 Norma Magnum ammunition to give operators a distinct advantage in both the extended and close-in fight and be able to transition rapidly from mounted operations to dismounted operations. Complete development of a High Frequency (HF) radio integrated into a cellular phone for use in low-profile operations. Continue development of a new ballistic algorithm, projectile drag coefficient, and weapon system for lethal target engagement beyond 2,500 meters. Continue development of a small unmanned aerial system (sUAS) to safely conduct reconnaissance of discovered illicit tunnels and routine inspections of underground municipal infrastructure (UMI). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental efficiencies and economic assumptions.					
Title: TRAINING TECHNOLOGY DEVELOPMENT ***Description:*** The TTD Subgroup's objective is to provide SOF, DoD, and the interagency community with agile, rapid response, R&D capabilities for optimizing performance in the operational environment while increasing readiness for tomorrow's threats. To meet this objective, the subgroup develops training technologies that are performance outcome focused in the areas of immersive and adaptive learning environments; human performance tools and techniques; mobile learning solutions; and advanced education and technical skill enhancement methods. TTD's innovative training capabilities are implemented globally to prepare for critical missions in any operational environment to identify, disrupt, and defeat terrorist threats. ***FY 2018 Plans:*** Complete an evaluation of tools and techniques used by Special Operations to optimize and maintain cognitive performance through a comprehensive literature review and controlled study. Complete the implementation refinement of a program and next generation technology designed to enhance visual acuity and improve	4.867	6.217	6.140	-	6.140

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C. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
operational visual task performance. Complete the development of task force officer verification and refresher training accessible via a mobile device application. Complete the development of a virtual reality training part task trainer capability for pre-mission tasks associated with AC-130 operations. Complete the evaluation of a reactive shooter course incorporating wearable device human performance measures and training simulation technology. Complete the development of training software for officers to accomplish immersive use of force decision-making training from a desktop computer. Complete the development of an automated capability to automatically diagnose shooter performance. A full analysis of data collected from sight alignment, breathing, trigger process, and shot placement will be provided to coaches and instructors to enhance individual fundamental shooting skills. Continue the development of a Virtual Reality (VR) simulated city environment where students will be immersed into realistic training scenarios, such as surveillance, with representative quantities and behaviors of non-player characters (NPCs) including people and vehicles. Initiate the development of interactive instructional videos consisting of human like avatars demonstrating applied Explosive Ordnance Disposal skills for use as instructional aids in the classroom and student independent study. Initiate the development and evaluation of a synthetic intelligence, surveillance, and reconnaissance (ISR) system to train Full Motion Video (FMV) ISR operational knowledge, skills, and abilities without incurring the costs of utilizing live ISR platforms. Initiate the enhancement of an existing human performance application to incorporate the recording and analysis of mental performance indicators such as stress, motivation, and fatigue thereby providing a common language for instructors, psychologists, and human performance coaches to understand and make decisions about training. Initiate the development and evaluation of an immersive virtual reality training and exercise environment integrated with tools and techniques, such as heart rate monitoring and brain imaging, to objectively assess training effectiveness based on human performance research. ***FY 2019 Base Plans:*** Complete the development of a Virtual Reality (VR) simulated city environment where students will be immersed into realistic training scenarios, such as surveillance, with representative quantities and behaviors of non-player characters (NPCs) including people and vehicles. Complete the development of interactive instructional videos consisting of human like avatars demonstrating applied Explosive Ordnance Disposal skills for use as instructional aids in the classroom and student independent study. Continue the development and evaluation of a synthetic Internet sandbox to enable intelligence analysts and information operations personnel to train on tools and methodologies for the collection, analysis, and exploitation of adversary's publicly available information (PAI), as well as engaging in large-scale Information Operations (IO) exercises, while mitigating the challenges and risks associated with training on the open, publicly visible Internet. Continue the development of a synthetic intelligence, surveillance, and reconnaissance (ISR) system to train Full Motion Video (FMV) ISR					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
operational knowledge, skills, and abilities without incurring the costs of utilizing live ISR platforms. Continue the enhancement of an existing human performance application to incorporate the recording and analysis of mental performance indicators such as stress, motivation, and fatigue thereby providing a common language for instructors, psychologists, and human performance coaches to understand and make decisions about training. Continue the development of an immersive virtual reality training and exercise environment integrated with tools and techniques, such as heart rate monitoring and brain imaging, to objectively assess training effectiveness based on human performance research. Initiate the development of a synthetic Internet sandbox to enable intelligence analysts and information operations personnel to train on tools and methodologies for the collection, analysis, and exploitation of adversary's publicly available information (PAI), as well as engaging in large-scale Information Operations (IO) exercises, while mitigating the challenges and risks associated with training on the open, publicly visible Internet. Initiate the development of a tactical decision making training system that is visually and auditorily immersive with realistic character representation and interaction, responds completely to all force application devices and methods, allows for unhindered use of tactical positioning, and is portable. Initiate the development of an MK-16 underwater breathing apparatus training capability consisting of an immersive mixed reality simulator focusing on scenarios to train emergency procedures. Initiate the development of a full motion video processing, exploitation and dissemination desktop training simulation that replicates a real world system along with a program of instruction for instructor-led training. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reductions were in support of Departmental efficiencies and economic assumptions.					
Accomplishments/Planned Programs Subtotals	113.366	101.230	125.271	25.000	150.271

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

E. Acquisition Strategy

N/A

F. 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
Total Program Element	45.534	18.966	24.199	24.532	-	24.532	25.041	25.493	25.992	26.496	Continuing	Continuing
313: *Foreign Comparative Testing*	45.534	18.966	24.199	24.532	-	24.532	25.041	25.493	25.992	26.496	Continuing	Continuing

Note

The Foreign Comparative Testing (FCT) Program Element (PE) focuses on Pre-Engineering and Manufacturing Development (Pre-EMD) and Proof of Principle prototypes derived from evaluation of foreign equipment that will provide the U.S. Armed Services, U.S. Special Operations Command (USSOCOM), and Defense agencies capabilities to counter emerging threats. FCT's broad reach across our allies and friendly foreign countries enables development of innovative, cost effective, and interoperable solutions for the Department of Defense (DoD), Multi-Service and Combatant Command (CCMD) priority requirements. FCT also increases competition, ensuring our personnel have access to the best technology available.

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The FCT program supports the warfighter by leveraging technologies and equipment developed by allied nations and coalition partners to counter emerging threats, thereby enhancing U.S. warfighting capabilities while lowering U.S. development costs and accelerating the DoD acquisition process. FCT supports DoD best practices by incentivizing the use of prototyping and experimentation in advancing technological solutions to warfighter problems and acts as a hedge against threat developments. FCT enhances interoperability, facilitates international collaboration, increases competition, and enables more efficient and affordable transition of technologies into acquisition programs of record. Authorized by Title 10, U.S. Code, Section 2350a (g), the FCT program is managed by the Office of Secretary of Defense (OSD) Deputy Assistant Secretary of Defense Emerging Capability & Prototyping (DASD(EC&P)), Comparative Technology Office (CTO). FCT projects are sponsored by the Military Services and USSOCOM. Evaluation processes for project selection include a detailed review to confirm the proposed item addresses valid requirements and DoD priorities, a thorough market survey, and an emphasis on transitioning technologies into current or future programs of record.

The FCT program is a catalyst for teaming and other business relationships between foreign and U.S. industries. Many successful FCT projects result in the licensed production of a qualified foreign item in the United States. Other nations recognize the long-term value of such practices for competing in the U.S. Defense market and the resultant strengthening of the "two-way street" in Defense procurement. The result often means the creation of jobs and contributions to local economies throughout the United States. To date, companies from 34 states benefited from FCT projects.

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B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	19.343	24.199	24.910	-	24.910
Current President's Budget	18.966	24.199	24.532	-	24.532
Total Adjustments	-0.377	0.000	-0.378	-	-0.378
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.353	-			
• FFRDC Transfer	-0.021	-	-	-	-
• Other Program Adjustments	-0.003	-	-0.213	-	-0.213
• Economic Assumption	-	-	-0.165	-	-0.165

Change Summary Explanation

The FY 2017 to FY 2018 profile increase reflects funding for Department priorities supporting DoD best practices and objectives to promote effective competition by improving DoD outreach for technology and products from global markets through risk reducing prototypes.

FY 2019 baseline decrease is being applied to fund other DoD requirements and priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
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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
313: *Foreign Comparative Testing*	45.534	18.966	24.199	24.532	-	24.532	25.041	25.493	25.992	26.496	Continuing	Continuing

A. Mission Description and Budget Item Justification

FCT funding supports projects that evaluate foreign equipment and prototypes as potential capabilities to counter emerging threats. Individual projects typically cost less than $1.200 million, last 24-36 months, and focus on pre-Engineering and Manufacturing Development (pre-EMD) and proof of principle prototypes of innovative technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Mobile Land Based Anti-Ship Fires (Army) ***Description:*** Integrate existing Norwegian Naval Strike Missile (NSM) and four-pod launcher onto a standard U.S. Army Palletized Load System flat rack and demonstrate NSM launch and engagement of an over-the-horizon maritime target. This Heavy Expanded Mobility Tactical Truck (HEMTT) mounted system enables Army and Marine Corps forces to support joint force freedom of movement and action through the projection of power from land into the maritime domain. Currently, there is no mobile, land-based, over-the-horizon, anti-ship warfare capability. The goal of this project is to evaluate an asset that could fill this critical capability gap. In 4Q FY 2017, a contract was awarded to procure the launcher and missile system from the vendor. ***FY 2018 Plans:*** Demonstrate the system in operational scenarios. Seven phases of testing are scheduled culminating in a live-fire demonstration at Rim of the Pacific Exercise 2018. System performance will be documented in each scenario. Complete final test and FCT closeout reports. If successful, the HEMTT mounted NSM will transition as an interim Mobile Land Based Anti-Ship Fires capability while the Army develops an organic capability, currently planned for Long Range Precision Fires Increment II. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.	1.230	1.430	-
Title: HALO Integration with Common Remotely Operated Weapon Station (CROWS) (Army) ***Description:*** FY 2017 New Start - The CROWS provides the capability to locate and attack targets while gunners remain under armor. The HALO system is an add-on image processor that enhances existing camera streams to allow for continuous standard and Infrared (IR) image “fusion” and a significant reduction in motion blur for the CROWS. The CROWS equipped with a HALO system will increase lethality and force protection by greatly improving image clarity and target recognition capability; and increase surveillance capability in a degraded visual environment. During FY 2017, test items and data characterization equipment were procured.	0.900	0.300	-

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
FY 2018 Plans: Send sensors (IR and Daytime Cameras) to vendor for integration. Conduct developmental testing, system level testing, and optimize system integration. Pending successful testing, the HALO system will be added to CROWS Increment II Specification and procured as part of overall CROWS production. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.			
Title: Compact Long Range Observation System (United States Special Operations Command ((USSOCOM)) ***Description:*** FY 2017 New Start - Project evaluates a lightweight, low-power, hand-held precision targeting device to enhance target observation, recognition, and identification of targets during day and night operations at long range. Initiated test planning and procurement of test articles in FY 2017. ***FY 2018 Plans:*** Complete procurement of test articles in 1Q FY 2018. Conduct laboratory/safety testing during 1Q-2Q FY 2018. Conduct operational user demonstrations during 3-4Q FY 2018. Prepare FCT project close-out report and prepare Milestone C Decision package by end of FY 2018. Upon successful testing, system will transition directly to Special Operations user community. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.	0.663	0.275	-
Title: E-band Communications (Air Force) ***Description:*** This project evaluates an E-band (71-86 gigahertz) radio system's capability to increase communications throughput by an order of magnitude or greater over deployed military systems. Completed Phase I laboratory testing 3Q FY 2017. Completed Phase II Field Testing 4Q FY 2017. Complete final test and closeout reports 1Q FY 2018 with FY 2017 funds. Following the FCT, the test item will transition to the Air Force Research Laboratory in New Mexico for additional rooftop testing under the W/V-band Satellite Communications Experiment Program. Additionally, the technology could be used today for other line-of-sight applications. Although this project did not meet the one million dollar threshold it was included in this section because of a large investment in FY 2016.	0.480	-	-
Title: Rifle Accessory Control Unit (Navy/USMC) ***Description:*** Evaluates a rifle-mounted, programmable button device that enables operation of various electronic weapon accessories and radios from a central control point with increased speed while maintaining hands on the rifle and eyes on the target. Completed Phase I laboratory testing in 1Q FY 2017. Received upgraded Phase I test articles in 2Q FY 2017. Completed	0.399	0.283	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Phase I field testing during 4Q FY 2017. Although this project did not meet the one million dollar threshold, it was included in this section because of a large investment in FY 2016. ***FY 2018 Plans:*** Complete Phase II laboratory testing 1Q FY 2018. Receive upgraded Phase II test articles in 2Q FY 2018. Complete Phase II field testing in 3Q FY 2018. Complete final test and close-out reports by end of 4Q FY 2018. If successful, the technology will transition to USMC Program Manager, Marine Expeditionary Rifle Squad. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.			
Title: Compact High Power Radio Frequency Directed Energy (HPRF-DE) Source (Navy/USMC) ***Description:*** This project tests state-of-the-art HPRF magnetron microwave tubes and solid state power modulators, and evaluates the non-lethal effects offered by this technology. This approach provides the warfighter a capability between “shouting and shooting” by delivering electromagnetic energy that will disrupt, disable, or potentially destroy critical vehicle/vessel electronic circuitry. Completed Phase I Open Air Effects Testing and initiated Phase II Radio Frequency Output Characterization Test Planning in FY 2017. Although this project did not meet the one million dollar threshold, it was included in this section because of a large investment in FY 2016. ***FY 2018 Plans:*** Complete Phase II Radio Frequency Output Characterization test during 1Q FY 2018. Complete Phase II Static Open Air Effects test in 2Q FY 2018. Complete System Safety Analysis, Prototype Vessel Temporary Installation and Integration, and Dynamic Developmental Testing and provide transition decision in 4Q FY 2018. Complete final technical test and project closeout reports during 4Q FY 2018. If successful, potential transition to various vehicle or vessel stopping programs within the Coast Guard, Navy, and Marine Corps. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.	0.430	0.443	-
Title: Enhanced Shipboard Navigation (Navy) ***Description:*** This effort tests the capability of a multi-constellation Global Navigation Satellite System (GNSS) receiver to function as an additional navigation source to existing military Global Positioning System (GPS) solutions for U.S. Naval surface ships and airborne applications. This testing will provide valuable insight into the potential benefits of using these signals in a U.S. military environment. Differences in positioning and timing between the foreign GNSS receiver and the platform's principal military GPS receiver may indicate to the platform that it should select an alternate, non-satellite navigation source. Completed anechoic	0.670	0.260	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
chamber test equipment modifications and initiated final testing in FY 2017. Although this project did not meet the one million dollar threshold, it was included in this section because of a large investment in FY 2016. ***FY 2018 Plans:*** Complete final test and prepare closeout and test reports for decision package 1Q-2Q FY 2018. Participate in Trident Warrior exercise during 4Q FY 2018. If successful, transition to the Global Positioning Navigation and Timing Systems program of record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.			
Title: Low Cost Autonomous Classification of Ships and Submarines (Navy) ***Description:*** This project will evaluate an Australian-developed signal processing algorithm and sensor based on underwater measurement of acoustic intensity at low frequency near the seafloor. The algorithm has the ability to classify surface and sub-surface targets. Initiated test planning, Project Arrangement with Australia, and test article procurement in FY 2017. ***FY 2018 Plans:*** Complete Project Arrangement with Australia to support collaborative testing and test article procurement in 1Q FY 2018. Conduct at-sea testing at Fort Pierce, Florida in 2-3Q FY 2018. Complete test reports and make procurement decision 4Q FY 2018. If successful, the technology will transition to the Navy's Fixed Surveillance System Program of Record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.	0.436	0.600	-
Title: High Power Radio Frequency (HPRF) for Counter Unmanned Aerial Systems (CUAS) (Navy/USMC) ***Description:*** FY 2017 New Start - This project integrates and tests HPRF directed energy source components with various off-the-shelf sensor technologies to provide a complete CUAS prototype system that provides the capability to detect, track, identify, engage, and defeat low, slow, and small UAS. No fielded non-kinetic HPRF CUAS systems currently exist. Project initiated and initial funds received in 3Q FY 2017. Initiated test planning and test article procurement in 4Q FY 2017. ***FY 2018 Plans:*** Complete test planning and test article procurement in 1Q FY 2018. Conduct Phase I UAS effects testing in 2Q FY 2018. Provide Phase I test report in 3Q FY 2018. Pending Phase I test results, initiate Phase II beam steering prototype design. ***FY 2019 Plans:***	0.962	0.559	0.784

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Conduct Phase II system level testing against UAS 2Q FY 2019. Complete final test and closeout reports by end of 3Q FY 2019. If successful, an operational prototype will be available as a Quick Reaction Capability in support of urgent needs and results will inform various program office acquisition decisions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding supports development and delivery of a beam steering prototype for testing.			
Title: Aerial Ground Mapping for Characterizing Landing Zones (Air Force) ***Description:*** FY 2017 New Start - Test airborne electromagnetic ground survey techniques currently used in commercial applications for characterizing landing zones for military aircraft. This could replace the current approach of inserting manned teams on the ground to perform the manually intensive, time consuming task of characterizing potential landing zones, often in hostile environments. Completed Phase I Laboratory and Static Testing in FY 2017. ***FY 2018 Plans:*** Conduct Phase II system baseline testing on the ground in 2-3Q FY 2018. Complete Phase II test report in 4Q FY 2018. Conduct Phase III system testing from an aerial platform in 2-3Q FY 2019 with FY 2018 funding. Complete test and closeout reports in 4Q FY 2019 with FY 2018 funding. If successful, will transition to the Air Force Research Laboratory for additional developmental/ operational testing and user demonstrations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding drops to zero in FY 2019 due to project completion.	0.635	0.365	-
Title: Future X-Band Radar (Navy) ***Description:*** FY 2017 New Start - Tests an off-the-shelf open-architecture Active Electronically Scanned Array (AESA) X-band aircraft radar for potential application to the Navy's Air and Missile Defense Radar (AMDR) program for ships. Currently, AMDR lacks a modern AESA X-band component to provide horizon surveillance against current and future threats. Completed initial test planning in 4Q FY 2017. ***FY 2018 Plans:*** Initiate test article fabrication throughout FY 2018. ***FY 2019 Plans:*** Receive test article 1Q FY 2019. Conduct lab testing throughout FY 2019. Conduct shipboard testing in FY 2020 with FY 2019 funding. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.500	1.500	0.500

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
The majority of funds for this effort are required for test article procurement which is expected to occur in FY 2018. Funding decreases in FY 2019 for test events.			
Title: Autonomous Anti-Submarine Warfare (ASW) Training Target (Navy) ***Description:*** -FY 2017 New Start - Demonstrate the capabilities of an off-the-shelf autonomous underwater vehicle for ASW training. This system accurately replicates the acoustic signature of threat submarines and provides a significant enhancement in training effectiveness over decades old technology currently in use. Initiated test planning in 4Q FY 2017. Conduct Phase I system baseline testing and evaluation throughout FY 2018 with FY 2017 funding. Continues in FY 2019 with FY 2019 funding. ***FY 2019 Plans:*** Conduct Phase II delta testing and evaluation throughout FY 2019. Complete final test and closeout report in 4Q FY 2019. If successful, the Navy anticipates purchasing several ASW Training Targets under an Abbreviated Acquisition Program. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2018 FCT funds not required as U.S. Navy sponsor funding will pay for FY 2018 testing support. FY 2019 FCT funds are required for Phase II delta testing.	0.600	-	0.600
Title: Low Cost Innovative Projects (Projects Less Than One Million Dollars Each): ***Description:*** OSD CTO selected multiple low cost projects in the areas of Force Protection, Force Support, Anti-Access/Area Denial, Robotics and Autonomous Systems, Interoperability and Countering Unmanned Systems. These projects were selected to deliver proof of principle prototypes for evaluation, assessment, and Service adoption within 24 to 36 months. -Soldier/Sniper Weapon Observation and Reconnaissance Device (Navy): Tests a rifle mounted, Android command and control device to provide enhanced situational awareness and targeting capabilities at the individual soldier level. Completed Phase I prototype lab testing in 2Q FY 2017. Completed Phase II engineering field test and final reports during 4Q FY 2017. If successful, the technology will transition to Program Manager, Marine Intelligence. -High Efficiency Flexible Photovoltaics (Navy): Tests high efficiency, lightweight, flexible solar cells for cross-domain military applications that will increase power for Unmanned Aerial Vehicles, small satellites, man-portable and ground-based renewable energy systems. Complete solar backpack, Unmanned Aerial Vehicle, and simulated space testing in 1Q FY 2018 with FY 2017 funding. If successful, transition decision and final closeout report expected in 2Q FY 2018. -Cruise Missile Gas Turbine Engine (Navy): FY 2017 New Start - Tests an off-the-shelf, multi-fuel turbine engine currently in use in various foreign missile systems to provide up to a 200 percent performance increase for legacy US Navy missile systems. Initiated test planning in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Autonomous Aircraft Material Maintenance (Navy): FY2017 New Start - Tested a trailer-mounted, autonomous cold spray metallization technology for repair of corrosion damaged areas on aircraft. Initiated test article contract award preparation in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds.	7.472	2.659	0.100

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
-Advanced Energy Storage and Power Batteries (Navy): FY 2017 New Start - Tests advanced lithium-ion batteries and new cell chemistries for military vehicle applications that will, at a minimum, double energy density. Initiated test planning in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Gimballed Laser Target Designator (Navy): FY 2017 New Start - Tests a miniature 3-axis stabilized electro-optic/infrared turret payload with integrated laser designator on a Group 1 Puma Unmanned Aerial Vehicle. Initiated test planning in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Energy Storage for Directed Energy Weapons and Sensors (Navy): FY 2017 New Start - Tests foreign graphene-based ultra-capacitor technology against industry leading domestic products to enable high energy storage capabilities necessary for directed energy weapons and sensors. Receive test articles and conduct phase I individual cell testing during 1-2Q FY 2018 with FY 2017 funding. Conduct phase II module configuration testing in 3Q FY 2018 with FY 2017 funding. Complete final test and closeout reports in 4Q FY 2018. If successful, the technology will transition to the Multifunction Energy Storage Future Naval Capability effort. -Tunable Laser Eye Protection (Air Force): FY 2017 New Start - Tests a prototype active tunable eye protection system for aircraft pilots to counter laser threats across different wavelengths. Received test article 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Gallium Nitride Amplifier Study of Space Environment Radiation Tolerance (Air Force): FY 2017 New Start - Comparatively tests foreign and domestic Gallium Nitride (GaN) technology in simulated space radiation environments. GaN technology offers 5 to 10 times performance improvement over legacy technology. Initiated performance benchmark testing in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Advanced Mobile Universal Electrical Tester (Air Force): Evaluates a handheld, wireless automated test device for rapid identification of aircraft electrical system failures. Conduct extended operational testing on various military aircraft throughout FY 2018 using FY 2017 funds. Complete final test and closeout report in 4Q FY 2018 with FY 2017 funding. If successful, this technology will transition to the Air Force’s automated test equipment program office. -Secondary Propulsion Thrusters (Navy): Tests pump-jet propulsion technology to replace existing hydraulic propeller-based submarine secondary propulsion system which is plagued by high procurement, operational, and maintenance costs. Prototype lab testing will continue throughout FY 2018 with FY 2017 funding. If successful, potential exists for technology insertion for Virginia-class Block VI and baseline design for Columbia-class submarines. -Low Cost Small Satellite Components (Navy): Tests mature and cost effective foreign small satellite components including Attitude Determination and Control Systems (ADCS), Electrical Power Systems (EPS), and X-band radios to enhance on-going US Navy nanosatellite development programs. Completed ADCS and EPS testing in 4Q FY 2017. Complete X-band radio testing in 3Q FY 2018 with FY 2017 funding. Complete final closeout report in 4Q FY 2018 with FY 2017 funding. If successful, technology will transition to the Naval Nanosatellite Program of Record. -Underwater Wireless Power Transfer (Navy): Evaluates foreign wireless power transfer systems for potential use in Navy underwater systems and other defense applications. Wireless power transfer enables enhanced endurance of autonomous			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
underwater vehicles and sensors, increased situational awareness, and new mission capabilities. Completed phase III pier-side testing in 4Q FY 2017. Conduct user demonstrations throughout FY 2018 with FY 2017 funding. If successful, transition potential exists for various Department of Defense programs. -Millimeter Wave Sensing for Autonomy (Navy): Tested technology that enables rapid and affordable evaluation of commercial automotive millimeter wave radar technology for defense applications including unmanned aerial systems. Completed flight test events in 4Q FY 2017. Complete final closeout report in 1Q FY 2018 with FY 2017 funding. If successful, the technology will transition into the Low-Cost Unmanned Aerial Vehicle Swarming Technology Innovative Naval Prototype Program. -Small Anti-Jam GPS Antenna for H-1 (Navy): Tested a small anti-jam Global Positioning Satellite (GPS) antenna system for helicopters, Group 3/4 Unmanned Aerial Vehicles, and ground vehicles to provide a counter GPS signal jamming capability to size, weight, and power constrained vehicles. Completed Phase I anechoic chamber testing 3Q FY 2017. Completed Phase II flight testing 3Q FY 2017. Complete final test and closeout report in 2Q FY 2018 with FY 2017 funding. If successful, the technology will transition to the Navy's H-1 Helicopters Program Office for fielding. -Software Defined Network for Maneuverable Agile & Resilient Traffic (Navy): Tests network routing technologies that represent a paradigm shift for mission flexibility because network control is moved from a distributed architecture on proprietary devices to a centralized architecture using open software operating on low cost, generic hardware. Widely used by large scale information technology companies, this approach significantly reduces the time and effort required to conduct network configuration management. Completed comparative technology assessment in FY 2017. Conduct user demonstrations in a prototype environment throughout FY 2018 with FY 2017 funding. If successful, the technology could transition into large scale network architectures across the DoD. -Improved Steels (Army): Tests new classes of high nitrogen steels to improve durability and protection of vehicles. Completed coupon mechanical, weldability, corrosion and initial ballistic performance testing in FY 2017. Testing continues on full size plates in FY 2018 with FY 2017 funding. If successful, will transition to Program Executive Office Ground Combat Systems and Army Research Development and Engineering Center. -Sappherios Sensor System (Army): Tests unattended ground sensor system comprised of dozens of rapidly deployable miniaturized seismic-acoustic, visual, and radar sensors to detect activity over large areas for long periods. Provides real-time autonomous situational awareness by deploying sensors from UAS. Completed developmental testing of enhanced sensor system 4Q FY 2017. Conducted operational evaluation of enhanced sensors as part of Adaptive Red Team/Technical Support and Operational Analysis event at Muscatatuk Urban Training Center 4Q FY 2017. Complete system testing in FY 2018 with FY 2017 funding. If successful, the technology will transition to Program Manager (PM) Close Combat Support, PM Ground Sensor, and PM Marine Tactical Remote Sensor System. -Soldier Power with Inductive Recharge and Intelligent Textiles (Army): Tests e-textiles that incorporate wireless power and data distribution, in a plug-and-play capability for various worn Soldier systems. System will give soldier a tactical edge by improving sustainability, increased operational time in the field, and reduced logistic support requirements. Received test articles from two companies and completed initial lab testing in FY 2017. Complete comparative testing, field demonstrations, and final reporting			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
in FY 2018 with FY 2017 funding. Upon successful testing, system will transition to Army, Program Executive Office Soldier and Marine Corps, PM Expeditionary Power Systems. -Evaluation of Towed Jumper Emergency Parachute Assembly (Army): Tests an emergency parachute system used to safely descend a towed jumper, an Airborne soldier whose equipment malfunctioned and is dragged behind the aircraft. Allows the Airborne soldier to safely descend regardless of aircraft exit and consciousness. Operational testing with crash test dummies completed in 4Q FY 2017. Complete reliability testing in FY 2018 with FY 2017 funding. Upon successful testing, system will be installed in C-130 and C-17 assets supporting Airborne operations and transitioned to Product Manager Soldier Clothing and Individual Equipment. -M3E1 Integrated Fire Control (Army): Tests an integrated Fire Control System for the M3E1 Multi-Role Anti-Armor Anti-Personnel Weapon System. Provides enhanced target engagement capability that significantly improves first round probability of hit in day or night with less collateral damage. Completed developmental and safety testing at vendor facility in 4Q FY 2017. This effort continues in FY 2018 with FY 2018 funds. -Falcon Chemical Agent Sensor (Army): FY 2017 New Start – Tests a chemical agent detector equipped with a tunable infrared laser which simultaneously identifies and precisely localizes smaller chemical threat plumes with higher sensitivity and improved accuracy. Developed and finalized functionality and operational testing plans in FY 2017. Functionality and performance tests will be conducted in FY 2018 with FY 2017 funding. Operational testing and demonstrations will be conducted in 4Q FY 2018 with FY 2017 funding. If successful, the technology will transition to the Joint Program Executive Office for Chemical Biological Defense for Nuclear Biological Chemical Reconnaissance Vehicles. -Autogated White Phosphor Image Intensifier Tubes (USSOCOM): FY 2017 New Start – Tests auto-gated white phosphor image intensifier tubes integrated into existing night vision systems to enable greater detection, recognition, and identification ranges for head mounted goggles, hand held surveillance devices, and weapon mounted sights. Completed project test planning. Receipt of test items, fabrication, and integration of test articles for baseline evaluation in FY 2018. This effort continues in FY 2018 with FY 2018 funds. ***FY 2018 Plans:*** -Holographic Immersion Simulation System (Navy): Test a deployable training system that renders three dimensional holographic environments at interactive frame rates to provide greater training realism and develop faster reactionary skills and improved decision making. Conduct single and multiple user configuration user assessments throughout FY 2018. If successful, the technology will transition to the Indoor Simulated Marksmanship Training Program of Record. -Cruise Missile Gas Turbine Engine (Navy): Receive test articles 1Q FY 2018. Conduct Phase I and II engine performance assessment from 2-4Q FY 2018. If successful, the technology will transition to the Navy's Precision Strike Weapons Program. -Autonomous Aircraft Material Maintenance (Navy): Receive test article in 2Q FY 2018. Conduct process validation on V-22 and H-1 aircraft during 3-4Q FY 2018. This effort continues in FY 2019 with FY 2019 funds.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
-Advanced Energy Storage and Power Batteries (Navy): Receive test articles during 1Q FY 2018. Initiate performance and safety testing in 2Q FY 2018. Complete testing in 2Q FY 2019 with FY 2018 funding. Complete final test and closeout reports in 3Q FY 2019 with FY 2018 funding. If successful, the technology will transition to various Marine Corps ground vehicle programs. -Gimballed Laser Target Designator (Navy): Complete laser safety review and test planning during 1Q FY 2018. Receive test article during 2Q FY 2018. Conduct flight test during 3Q FY 2018. Complete final test and closeout report during 4Q FY 2018. If successful, payload will transition to Group 1 Unmanned Aerial System Program of Record. -Tunable Laser Eye Protection (Air Force): Conduct physical, human effects, and compatibility testing throughout FY 2018. This effort supports next generation laser eye protection technology development. If successful, the technology will transition to the Naval Ophthalmic Support and Training Activity for manufacture. -Gallium Nitride Amplifier Study of Space Environment Radiation Tolerance (Air Force): Initiate radiation effects testing in 2Q FY 2018. If successful, best performing technology will be a candidate for operational testing on the experimental Navigation and Timing Satellite 3. -Crash Resistant, Ballistic Tolerant, Fuel Cell Qualification for H-1 Helicopters (Navy): Qualify a second source of crashworthy self-sealing fuel cell technology currently being used on foreign platforms for use on US Navy AH-1Z Viper and UH-1Y Venom attack helicopters. Initial Phase I test efforts were delayed due to failures that required a product redesign. Modified Phase I test article received 3Q FY 2017. Initiate Phase I retests during 4Q FY 2017. If successful, technology will be made available for procurement to replace currently fielded fuel cells by attrition. -M3E1 Integrated Fire Control (Army): Complete system evaluation 1Q FY 2018. Assessment of user requirements and test/ evaluation in support of system full material release. Will transition from a test and evaluation effort to a direct solution for an Urgent Material Release for 1,111 systems in 2Q FY 2018. -Autogated White Phosphor Image Intensifier Tubes (USSOCOM): Conduct Safety and Technical Testing 2Q FY 2018. Plan and participate in Operational User Demonstration in 3Q FY 2018. Prepare Milestone C Decision package and final test report in 4Q FY 2018. Upon successful testing, the Image Intensifier Tubes will be integrated into Night Vision Devices for the Special Operations Forces user community. ***FY 2019 Plans:*** -Autonomous Aircraft Material Maintenance (Navy): Complete testing in 1Q FY 2019. Complete final test and closeout reports in 3Q FY 2019. If successful, the technology will be available for follow-on procurement and fielding by the Navy's Fleet Readiness Centers. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
FY 2019 funding is reduced as currently selected projects complete their 24-36 month evaluation. In FY 2019, these funds become available for new projects as captured below in the OSD focus areas, Asymmetric Force Application, Autonomous Systems, Information Operations and Analytics, Electromagnetic Spectrum Agility, and Force Logistics.			
Title: Asymmetric Force Application and Autonomous Systems Focus Areas	1.831	7.956	11.468

Description: FCT will invest in cross-domain, innovative, non-traditional technologies for new and emerging capabilities from international partners to enable cost-leveraging, increase competition, and provide more efficient solutions for our forces during maneuver and engagement operations. Solutions will reduce U.S. reliance on overleveraged blue capabilities and creatively exploit increasingly capable adversary systems while adjusting the cost curve in our favor. Applications of particular interest are those able to provide an innovative technology offset and/or cost calculus advantage. Our allies have made particular progress in the development of systems that offer a significant cost advantage in procurement or operation and reduce the amount of manpower necessary to effectively conduct operations. In addition, FCT will continue to seek out increased interoperability across platforms and systems. These technologies will be likely candidates for evaluation under the FCT program.

FY 2018 Plans:
During FY 2018, FCT will focus on selecting projects supporting the below Asymmetric Force Application and Autonomous System Areas:
- Technologies to counter threats associated with integrated air defense systems
- Technologies that enhance the ability to conduct long range penetrating strike
- Offensive and defensive air superiority operations
- Mobile unmanned systems that must maneuver in an environment with little or no human assistance
- Systems that aid human cognitive tasks

FY 2019 Plans:
During FY 2019, FCT will focus on selecting projects supporting the below Asymmetric Force Application and Autonomous System Areas:
- Technologies to counter threats associated with integrated air defense systems
- Technologies that enhance the ability to conduct long range penetrating strike
- Offensive and defensive air superiority operations
- Mobile unmanned systems that must maneuver in an environment with little or no human assistance
- Systems that aid human cognitive tasks

FY 2018 to FY 2019 Increase/Decrease Statement:

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
This focus area shows a rise in funding from FY 2017/FY 2018 into FY 2019. The reason for the increase is because, during the years of execution (FY 2017/FY 2018), projects are selected, funded, and displayed individually in this R-2, thus reducing FY 2017/FY 2018 funding in this focus area.			
Title: Information Operations and Analytics and Electromagnetic Spectrum Agility Focus Areas ***Description:*** FCT will invest in cross-domain, innovative Information Operations and Analytics and Electromagnetic Spectrum Agility evaluations of new and emerging capabilities with international partners. Solutions will increase U.S. options for enhancing communications and situational awareness and allow the Department of Defense to operate with freedom of maneuver in the electromagnetic spectrum. ***FY 2018 Plans:*** During FY 2018, FCT will focus on selecting projects supporting the below Information Operations and Analytics and Electromagnetic Spectrum Agility Areas: - Provide the Joint Force enhanced communications and situational awareness within the Area of Responsibility to disrupt and delay adversary force from offensive operations - Counter adversary ability to use deceptive messaging to influence U.S. and Coalition operations - Develop capabilities to counter adversary command and control communications - Gain and attain access to spectrum for friendly forces, denying and/or degrading spectrum to our adversaries - Conduct Electromagnetic (EM) deception operations to degrade an adversary's understanding of our intent and capability - Prevent the adversary from leveraging the EM domain to conduct operations in other domains (i.e., air, space, maritime, and land) - Achieve new effects in the electromagnetic spectrum domain to include directed energy and radio frequency disruption - Evaluate low-cost, efficient or innovative international capabilities ***FY 2019 Plans:*** During FY 2019, FCT will focus on selecting projects supporting the below Information Operations and Analytics and Electromagnetic Spectrum Agility Areas: - Provide the Joint Force enhanced communications and situational awareness within the Area of Responsibility to disrupt and delay adversary forces from offensive operations - Counter adversary ability to use deceptive messaging to influence U.S. and Coalition operations - Develop capabilities to counter adversary command and control communications - Gain and attain access to spectrum for friendly forces, denying and/or degrading spectrum to our adversaries - Conduct Electromagnetic (EM) deception operations to degrade an adversary's understanding of our intent and capability - Prevent the adversary from leveraging the EM domain to conduct operations in other domains (i.e., air, space, maritime, and land)	0.967	4.535	6.780

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Achieve new effects in the electromagnetic spectrum domain to include directed energy and radio frequency disruption - Evaluate low-cost, efficient or innovative international capabilities ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This focus area shows a rise in funding from FY 2017/FY 2018 into FY 2019. The reason for the increase is because, during the years of execution (FY 2017/FY 2018), projects are selected, funded, and displayed individually in this R-2, thus reducing FY 2017/FY 2018 funding in this focus area.			
Title: Force Logistics Focus Areas ***Description:*** FCT will invest in cross-domain, innovative force logistic technologies for new and emerging capabilities with international partners, including but not limited to these Defense-wide requirements that are consistent with strategic priorities: reducing soldier load, interoperability across platforms and systems, and energy solutions. ***FY 2018 Plans:*** During FY 2018, FCT will focus on selecting projects supporting the below Force Logistics Areas: - Reducing soldier load reduces the weight currently sustained by the individual dismounted soldier, including materials that enable weight reduction to individual weapons, ammunition, or portable missile systems - Increasing interoperability across platforms and systems will invest into technologies for mission-based on-demand routing, network, and information management, with a focus on command and control interoperability with coalition capabilities through integrated multi-level security enabled networks. Transition of MOSA capabilities which are portable, modular, partitioned, scalable, extendable, and secure - Improving energy solutions will include power systems and electronics designed for extreme cold to support arctic strategy and renewable energy options that can reduce force support and logistics requirements ***FY 2019 Plans:*** During FY 2019, FCT will focus on selecting projects supporting the below Force Logistics Areas: - Reducing soldier load reduces the weight currently sustained by the individual dismounted soldier, including materials that enable weight reduction to individual weapons, ammunition, or portable missile systems - Increasing interoperability across platforms and systems will invest into technologies for mission-based on-demand routing, network, and information management, with a focus on command and control interoperability with coalition capabilities through integrated multi-level security enabled networks. Transition of MOSA capabilities which are portable, modular, partitioned, scalable, extendable, and secure - Improving energy solutions will include power systems and electronics designed for extreme cold to support arctic strategy and renewable energy options that can reduce force support and logistics requirements ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.791	3.034	4.300

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This focus area shows a rise in funding from FY 2017/FY 2018 into FY 2019. The reason for the increase is because, during the years of execution (FY 2017/FY 2018), projects are selected, funded, and displayed individually in this R-2, thus reducing FY 2017/FY 2018 funding in this focus area.			
Accomplishments/Planned Programs Subtotals	18.966	24.199	24.532

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Successful FCT's can transition to acquisition via several ways: As a pre-engineering and manufacturing development prototype the item tested could be a technology upgrade insertion into a current platform or program providing greater capability or prolonging the life of the weapon system. If the item was a proof-of-principle prototype the testing results could lead to informed/refined requirements generation providing better outcome for current planned U.S. system or could lead to a direct transition/ procurement should the item/article provide a new capability.

E. Performance Metrics

Strategic Goals Supported:
- Develop and Demonstrate Proof-of-Principle prototypes that fill capability gaps.
- Develop and Demonstrate Pre-EMD prototypes that address DoD strategic priorities.
- Develop and Demonstrate a prototype that informs/refines the acquisition process.

Measurable Outcomes:
- FCTs will demonstrate capability objectives within 24-36 months.
- In FY 2017, FCT had a transition rate of 70 percent for completed projects, exceeding the DoD Strategic Performance goal of 40 percent for demonstration programs.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*

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	91.979	16.618	18.662	18.644	-	18.644	18.827	19.106	19.441	19.810	Continuing	Continuing
225: *Joint DOD/DOE Munitions*	91.979	16.618	18.662	18.644	-	18.644	18.827	19.106	19.441	19.810	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The mission of the Department of Defense (DoD)/Department of Energy (DOE) Joint Munitions Technology Development Program (JMP) is to develop new and innovative warhead, advanced and disruptive explosive, fuzing, weapons effects, and lifecycle technologies and tools to enable significant improvements in conventional munitions. The JMP supports the development and exploration of advanced munitions concepts and enabling technologies that precede Service-specific system engineering. A Memorandum of Understanding signed in 1985 by DoD and DOE provides the basis for the cooperative effort and for cost-sharing the long-term commitment. The DoD JMP funds budgeted in this justification are matched, at a minimum, dollar for dollar by DOE funds. Through this interdepartmental cooperation, DoD's relatively small investment leverages DOE's substantial investments in intellectual capital and highly specialized skills, advanced scientific equipment and facilities, and computational tools not available within DoD. Under the auspices of the JMP, the integration of DOE technologies with Joint and Individual Services' needs has provided major advances in warfighting capabilities over many years and continues to play a crucial role in the exploration, development, and transition of new technologies needed by the Services.

The JMP has established a successful collaborative community of DoD and DOE scientists and engineers that develop technologies of interest to both Departments within a structured framework of technical reviews and scheduled milestones. The JMP is administered and monitored by the Office of the Secretary of Defense (OSD) and reviewed annually by the Munitions Technical Advisory Committee (TAC), which is comprised of munitions laboratory technical directors and senior executives from the Army, Navy, Air Force, Special Operations Command, the Defense Threat Reduction Agency, OSD, and DOE. Projects are organized in eight Technology Coordinating Groups (TCG) that bring together the disciplines necessary to properly evaluate technical content, relevance, and progress. The TCGs conduct semi-annual technical peer reviews of JMP projects and plans. DoD Service laboratory technical experts lead each of the TCGs to ensure that the technologies under development address high-priority DoD gaps, needs, and challenges. The JMP also promotes more in-depth technical exchange via short-term visiting scientist and engineer assignments at both the DOE and the DoD laboratories.

The JMP also works with the Defense Ordnance Technology Consortium (DOTC) and the National Armaments Consortium (NAC) of industrial suppliers to equitably and efficiently transition JMP technologies to defense industrial contractors.

The integrated DoD and DOE efforts within the JMP are transitioning new munitions' technologies to the Department and the defense industrial base through the advanced development process. The JMP is a focal point for collaborative work by nearly 300 DoD and DOE scientists and engineers. Technical leaders from both Departments consider the JMP a model of cooperation, both within their respective departments and between departments. The highly challenging technical objectives of the 32 current projects require multi-year efforts and sustained, long-term investments to achieve success.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	17.256	18.662	18.775	-	18.775
Current President's Budget	16.618	18.662	18.644	-	18.644
Total Adjustments	-0.638	0.000	-0.131	-	-0.131
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.617	-			
• Other Program Adjustments	-0.003	-	-0.006	-	-0.006
• FFRDC Transfer	-0.018	-	-	-	-
• Economic Assumption	-	-	-0.125	-	-0.125

Change Summary Explanation

FY 2019 adjustments are reflective of other program adjustments.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

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
225: *Joint DOD/DOE Munitions*	91.979	16.618	18.662	18.644	-	18.644	18.827	19.106	19.441	19.810	Continuing	Continuing

A. Mission Description and Budget Item Justification

The JMP seeks to develop technological advances in several munitions subject areas. These include: 1) improved modeling and simulation tools for munitions and system design and evaluation, including evaluation of lethality, vulnerability and the design of energetic materials (EM) and insensitive munitions (IM), 2) novel experimental techniques and material property databases to support modeling and simulation, 3) higher power and safer explosives and propellants, 4) miniaturized, lower-cost, and higher reliability fuzes, initiators, power systems, and sensors, 5) design tools to enable development of higher performance warheads and weapons, such as penetrators, that are hardened against high impact loads, and 6) tools to assess the health and reliability of the munitions stockpile and predict lifetimes based on these assessments. The supporting experimental research requires the development of new technologies related to the synthesis, processing, formulation, and characterization of advanced munition materials, components, and systems. This involves energetic material research, new fuzing concepts, dynamic testing of munition materials, and advanced characterization including high-rate in-situ diagnostics.

The JMP projects are divided into five technical focus areas: 1) Computational Mechanics and Material Modeling, 2) Energetic Materials, 3) Initiators, Fuzes, and Sensors, 4) Warhead and Penetration Technology, and 5) Munitions Lifecycle Technologies.

Each of the 32 projects has a detailed five year plan with objectives, tasks, deliverables and milestones that is approved annually by a group of 20-plus SES from the DoD munitions laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Computational Mechanics and Material Modeling	4.577	6.345	6.149
Description: Projects in this technical focus area develop physics-based computational tools, material models, and calibration and validation databases that support the design and development of weapon systems. These capabilities are intended to predict the complex phenomena across significant length (meso to continuum) and time (nano-seconds to minutes) scales. The tools will provide coupled, multi-physics and chemistry modeling capabilities that are scalable to massively parallel architectures for solving diverse problems across the weapons systems' research and development and acquisition communities. Numeric tools are the foundation that makes possible the integration of mechanics, materials science, physics, and chemistry. This focus area also includes an extensive experimental component consisting of: 1) phenomenological or "discovery" experiments that provide the physics basis for model development, 2) experiments directly coupled to model development and application, such as characterization, calibration, and validation experiments, or 3) the development of advanced test methods or device development. The specific projects in computational mechanics and material modeling are: - CTH (Sandia code) shock physics and Sierra/Solid Mechanics (SM) codes & model development and supporting experiments.			

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Arbitrary Lagrangian-Eulerian Three-Dimensional (ALE3D) code and model development. - Composite case technology and modeling. - Dynamic properties of materials, modeling and validation. - Energetic materials and polymers under dynamic and thermal loading. - Fragment impact and response experiments. ***FY 2018 Plans:*** - Develop and advance new material models in CTH for anisotropic shock wave propagation. - Determine equation of state (EOS) and constitutive property data on advanced/additive manufactured (AM) polymers. - Complete first experiment on stainless steel alloy examining adiabatic shear banding with both digital image correlation (DIC) and surface thermometry. - Complete implementation of new porosity based ductile damage model within ABAQUS with micro-inertia. - Perform experiments using High Energy Density Material (HEDM) and tomography to characterize incipient void nucleation and growth in titanium. - Complete PBX 9502 fragment impact test series. - ALE3D: Improve the multiphysics auto-contact, integrate improved strength models, and improve the failure and fragmentation models. - Complete the Insensitive Munitions Project Arrangement (IM PA) with the U.K. to develop a model to predict the effects of fragment impact on minimum smoke propellant motors on relevant tactical systems. ***FY 2019 Plans:*** - Release CTH Version 13.0. - Release Sierra Mechanics Version 4.52. - Determine the effects of thermodynamic non-equilibrium under high strain rate considered using the multi-scale methods in Carta Blanca. - Complete Ignition/violence characterization tests on pedigreed PBXN-9, Comp B, and Plastic Bonded eXplosive (PBX) 9501. - Release ALE3D Version 4.30. - Transfer key portions of Lawrence Livermore National Laboratory's Siboka workflow tools to one or more DoD platforms (Army Armament Research, Development & Engineering Center and Air Force Research Laboratory) for the development of warhead design optimization tools. - Continue to improve and release the MIDAS material database to the DoD and the DOE. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Small changes reflect minor budget fluctuations.			
Title: Energetic Materials (EM)	4.478	5.464	5.632

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Description: The goals of this technical focus area are to develop new Energetic Materials (EMs) and supporting technologies to satisfy the competing requirements for smaller, more lethal, and safer munitions. Work is primarily focused on explosives, gun and rocket propellants, and, to a lesser extent, pyrotechnics. The projects include development of: 1) new EMs, including new molecules in a range of particle sizes and morphologies, 2) new EM formulations, 3) a fundamental understanding of energetic properties and performance, and 4) computational tools for analysis of performance and sensitivity. New materials and formulations are developed with the recognition that costs must be reasonable, chemical feed stocks reliable, and manufacturing processes suitable for scale-up to production levels. Both Federal statute and Department policy direct the development of safer, less sensitive munitions. Making munitions less sensitive while maintaining explosive or propellant performance is a difficult challenge. This goal is best attained through a combination of new EM development, EM characterization, and more sophisticated modeling and simulation tools. It is cost prohibitive to qualify weapons for compliance with insensitive munitions requirements through testing alone. A better, and in many cases the only means, to qualify these weapons is with the combination of analysis based on validated computational tools and a few well-designed tests. The Department also needs munitions that provide selectable effects and improved lethality. To achieve these effects, weapons designers need to thoroughly understand the performance of EMs used in both the main weapon fill and the initiation systems. Distributed fuzing systems can provide selectable effects as well as safer munitions, but such complex, small-scale systems require more complete knowledge of EM detonation physics and in some cases, new EMs designed for this application. The desire for smaller and lighter munitions is driven in part by recommendations of the Long Range Research and Development Program Plan (LRRDPP) and the increasing dependence on unmanned weapons platforms and to some extent by the need to reduce logistical burden, especially energy consumption. New EMs are needed to meet the munitions weight and size requirements while maintaining and improving lethality, effects, and safety. In order to clearly establish overmatch, the Department is working to increase the range and speed of weapons and to develop weapons against hardened targets. This thrust includes the development of hypersonic and hyper-velocity weapons. These applications subject EMs to high accelerations and shock loads. To support the development of these new systems, we need to improve our ability to model EM under higher impact loads and to characterize relevant properties to determine their ability to survive in these aggressive environments. DoD may also need to develop new, more robust EMs that survive impact loads while maintaining lethality and the ability to initiate weapons under extreme conditions.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
TCG-III is also a forum for the exchange of information on new energetic materials, their performance and sensitivity characteristics, and physical models that can be used to predict the behavior of energetics under adverse and unplanned conditions. It is a venue in which collaboration opportunities can be identified to facilitate the transition of technology developed in the DOE to the DoD. The specific projects in the energetic materials technical focus area for FY 2018 are: - Synthesis, properties, and scale-up of new energetic compounds. - Insensitive munitions and surety. - Cheetah thermochemical code development and experiments. - Micro- and nano-energetics synthesis and initiation. - Hazards analysis of energetic materials. - Reactive processes in energetic materials. - Development of tools for energetic material performance characterization. - Explosives chemistry and properties, and new energetic materials formulation. - Thermal response of energetic materials. ***FY 2018 Plans:*** - Execute experiments on LX20 graded/ungraded mixtures to assess the predictive capacity of modeling capabilities of additively manufactured energetic material. - Develop detonation and post-detonation kinetics models for conventional and insensitive high explosives. Test and validate against small scale experiments (e.g., cylinder, plate push) for explosives based on TNT, RDX, NTO, DNAN, HMX, TATB (triaminotrinitrobenzene), FOX-7, Landau Level Mixing (LLM)-105, NQ, HNS, LLM-200, TNBA, 3,4 Dinitrophenol (DNP), LX20, halogenated (e.g., LX04, LX10, PBX 9407, ammonium perchlorate (AP)-based, etc.). - Synthesize functionalized acrylate monomers and optimize catalyst for nitro-group bearing monomers. - Demonstrate small scale x-ray determination of detonation product EOS in situ. - Report on aging of PBXN-103 underwater explosive formulation (Naval Surface Warfare Center-Indian Head). - Release foam filling computational models for use in predicting large material deformation from thermal boundary conditions via publication or computational subroutine. ***FY 2019 Plans:*** - Complete graded additive manufactured (AM) booster design experiments on selected designs including non-destructive evaluation of as-printed energetic material. - Integrate code capabilities to facilitate exploratory calculations (e.g., constant volume explosions at user specified conditions, EOS tables for hydro simulations (e.g., LEOS, SESAME), multiple constraints on formulation performance, etc.). Upgrade			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
graphical user interface to maintain and enhance functionality (e.g., heat of formation and density estimates) and compatibility with current versions of major operating systems. - Complete performance testing on energetic binders and then formulate main charge with energetic polymers. - Integrate pre and post-ignition modeling of thermal response in PBX 9501. - Report on ammonium perchlorate (AP) propellant thermal decomposition. - Develop high-speed, high-definition imaging capability and data-extraction method for material behavior and combustion front observation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in FY 2019 funding enables more effort focused on advanced and disruptive energetics #to increase range, speed, lethality, and effects of munitions.			
Title: Initiators, Fuzes, and Sensors ***Description:*** The goals of this technical focus area are to develop new materials, components, diagnostic techniques, and modeling and simulation tools for fuzing systems. Initiators, fuzes, and sensors must work reliably together to prevent unintended detonation, to correctly detect intended targets, and to initiate detonation when required. Projects in this focus area support the Department's needs to miniaturize fuzing systems. Smaller systems are required for several reasons including: 1) compatibility with smaller and lighter weapons systems, 2) trading volume in munitions for other components such as additional explosives, higher energy and power density power sources, or enhanced guidance systems, 3) increasing reliability through redundancy, for example, using of two or more smaller initiating systems, and 4) upgrading existing sub-munitions with smarter and more reliable fuzing systems. The miniaturization of fuzing systems requires new material and components, new power systems, new diagnostic techniques, and improved modeling tools for microdetonics. The Department also needs weapons systems with selectable effects, and these effects may be achieved with multi-point initiation systems. Such systems are inherently more complex and require improved characterization of initiator materials and components, as well as more sophisticated modeling and simulation tools. To attain greater precision and to avoid unintended collateral effects when weapons are used in the complex environment of counter-insurgency or counter-terrorist operations, target sensors must be reliable and provide high-fidelity discrimination. Projects in this focus area are developing technologies to achieve this level of performance in compact packages. The specific projects in the initiators, fuzes, and sensors technical focus area are: - Firing Systems Technology, comprising FireMod firing set code model development and validation, 1.6 hazard classification detonator development, and initiation and detonation physics on the millimeter scale. - Safe, Arm, Fuze and Fire Technology, comprising Initiation and Detonation, and Advanced Firing System Components.	3.681	3.067	3.187

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Advanced Initiation Systems, comprising diagnostics development, microdetonics, miniature initiation systems, and detonators for enhanced safety. - Thermal Battery Performance Modeling to develop a multi-physics modeling capability for thermal batteries. - Thin Film Thermal Batteries to develop, mature, and transition a method to produce a thin, conformal, low-cost thermal battery. - Vertical-Cavity Surface-Emitting Laser (VCSEL) sensors for proximity fuzing of munitions with very low size, weight, and power requirements. - Enabling Robust, Mode-Agile GPS-Denied Weapon Guidance through High-Efficiency Data Processing. ***FY 2018 Plans:*** - Deliver initial GPS-denied sensor hardware prototype and associated radar guidance software to DoD customer for evaluation. - Deliver documentation and training for Thermally Activated Battery Simulator (TABS) Version 5.0 to include improved single-cell modeling capabilities. - Demonstrate 3-cell stack configuration with < 50 millisecond (ms) rise to midvoltage and no shorting. - Integrate Photon Doppler Velocimetry microscope and complete report on Photon Doppler Velocimetry (PDV) microscope. Support flyer characterization by using PDV microscope in boombox. - Demonstrate synthetic aperture radar (SAR) image formation, SAR-on-SAR and radar-to-optical-feature extraction and correlation (ROFEC) on a workstation platform. - Fabricate flip-chip laser in 10x10 array format for vertical-cavity surface-emitting laser (VCSEL). - Status results and validation of simultaneous shock wave image framing technique (SWIFT), and explosive particle image velocimetry (PIV) diagnostic benchmark testing to advocates at the Army Research Laboratory for consideration and application to polymethyl methacrylate (PMMA) gap-test model validation. ***FY 2019 Plans:*** - Demonstrate the ability to model thin-film batteries and couple thermal and electrical performance. - Optimization of process to cut metallized glass/epoxy composites without damaging electrodes. - Demonstrate 10 Volt (V), 10-cell stack at 1 amphere/square centimeter (A/cm2) with < 50 ms rise to midvoltage and no shorting. - Delivery of SAR-on-SAR and ROFEC prototype hardware/software processor solution to DoD customer for evaluation. - Refine fabrication and complete optical characterization of VCSEL and complete g-testing. - Report status of photoactive high explosives (HE) project capabilities in preparation for specification of down-selected engineering applications, e.g., prompt versus deflagration to detonation transition (DDT) photo-active detonators. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase of FY 2019 would accelerate the transition of technology to the DoD for advanced modeling to optimize new weapons firing and detonation system design.			
Title: Warhead and Penetration Technology	3.063	2.968	2.878

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Description: This focus area supports the development of new warheads and penetrator weapons through advances in materials processing and characterization, instrumentation, and computational codes. Significant increases in warhead performance are directly attributed to our ability to understand and accurately model the physics and fine details of new warhead designs, and to advances in increasingly sophisticated material processing. The Department’s requirement to achieve more precise weapon effects with minimum collateral damage is supported by work on controlled fragmentation, non-fragmenting warhead cases, and multiphase blast explosives (MBX). More recently, increases in performance and reductions in vulnerability are being achieved through improved warhead integration into munitions using a systems-oriented approach. The goals for penetrator weapons are to investigate, develop, and transition advanced technologies for the design, development, and performance assessment of the next generation of high performance, precision strike weapons. This effort directly supports national initiatives to defeat hard and deeply buried targets, which are proliferating worldwide, and to deny/defeat weapons of mass destruction. The work addresses high-velocity penetration into granular materials (sand and soil), penetration into advanced high-strength, high performance, and ultra-high-performance concretes, new penetrator materials and designs, and non-inertial onboard instrumentation. The specific projects in the warhead and penetration technology focus area for FY 2018 are: - Multiphase blast munitions (MBX) technology. - Dynamic behavior of concrete. - Integrated munitions modeling & experimentation for penetration and MBX target coupling. - Modeling of strategic structures subject to ballistic impact or blast. - Concrete perforation and penetration modeling and experiments. - Explosive/metal interactions. - Structure, mechanical & shock-loading response, and modeling of materials. - Controlled effects warhead materials. ***FY 2018 Plans:*** - Implement improved user interface into the Peridynamics-Multiscale (PDMS) code. - Establish an exemplar AFX-1282 input deck with a composite case for modeling MBX flow in Arbitrary Lagrangian-Eulerian Three-Dimensional (ALE3D). - Complete report on continuum model validation for penetration through concrete. - Complete calculations of the flat-plate and curved-plate oblique shock experiments performed on titanium (Ta) with CartaBlanca and compare results with experimental data and recovered sample metallography. - Integrate new physical observations for improvement to the damage model and code over the progress made in FY 2017.			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Complete constitutive modeling of AF9628 Eglin Steel and validate models using Taylor Cylinder testing. - Identify the cause of the ductility characteristics of pure Zirconium (Zr). ***FY 2019 Plans:*** - Add a granular temperature model to ALE3D for improved modeling of MBX. - Element conversion of finite element modeling and discrete element modeling (FEM-DEM) with improved stability in ALE3D v4.32. - Complete mechanistic mesoscale simulations for concrete penetration. - Develop thermomechanical solution framework for hard-target penetration. - Concrete perforation and penetration modeling and experiments on high performance and ultra-high performance material. - Simulate 3D compact shear sample experiment on two materials of interest – possibly stainless steel or tantalum – using the 3D embedded element formulation. - Exercise new model within CartaBlanca for the sweeping detonation wave damage problem on tantalum. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Small changes reflect minor budget fluctuations.			
Title: Munitions Lifecycle Technologies ***Description:*** This focus area supports improving the Department's ability to understand measure, predict, and mitigate safety and reliability problems caused by materials aging and degradation in weapons systems. Current stockpile assessment methods typically focus on addressing materials aging and reliability problems after they occur, rather than anticipating, predicting, and avoiding future problems or failure mechanisms. The overall objective of this work is to develop a toolset of computational models that are able to quantitatively predict materials aging processes and ultimately improve the long-term reliability of weapons systems, subassemblies, and/or components. These objectives are achieved by identifying aging mechanisms, quantifying the rates at which those aging mechanisms occur, developing predictive models, and using these models to predict the munitions stockpile reliability. An additional objective of this work is to develop technologies and methodologies to enable munitions health management and condition-based maintenance. The specific projects in the munitions lifecycle technologies focus area are: - Predictive Materials Aging, including solder interconnect reliability, corrosion of electronics, and adhesive degradation. - Microelectromechanical systems (MEMS) reliability. - Military use of commercial off-the-shelf (COTS) electronics. - Complex system health assessment. - Physical/chemical reactive transport modeling of material/system aging and reliability.	0.819	0.818	0.798

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
FY 2018 Plans: - Validate predictions of adhesive degradation in humid environments in a unique geometry: smooth stainless steel surfaces. - Characterize chemical reaction kinetics of material for validation (e.g., RTV-734) for lifecycle out-gassing effects. - Characterize sorption/diffusion (S/D) parameters of chosen material and vapors and validate against single and multi-material experiments. - Validate shock isolation system modeling and compare to experimental results. - Experimentally characterize Foam plug(s) from AMRDEC MLRS M26 igniter. - Characterize chemical reaction kinetics of material for validation (e.g., RTV-734). - Release of preliminary, early prototype of physics-based lifetime predictive model to the DoD. - Transition first-principles (DRX) tin whisker mitigation methods to industry. ***FY 2019 Plans:*** - Experimentally characterize and model DOE & DoD material(s) of interest based on suspected impact on aging and outgassing. - Simulate multi-material experiments (MME) on DoD system (MLRS M26 ignitor). - Complete 3D, MME experiments for validation on identified systems of interest. - Simulate 3D compact shear sample experiment on two materials of interest – possibly stainless steel or tantalum – using the 3D embedded element formulation. - Use 3D experiments to determine outgassing effects of critical materials. - Transition tin whisker mitigation to commercial plating houses. - Develop datasets for electrochemical kinetics and damage distributions on aluminum under varying humidity and chloride-loading conditions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Small fluctuations reflect minor budget adjustments.			
Accomplishments/Planned Programs Subtotals	16.618	18.662	18.644

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603225D8Z / *Joint DOD/DOE Munitions Technology Development*	**Project (Number/Name)** 225 / *Joint DOD/DOE Munitions*

E. Performance Metrics

1. Transition of technologies developed by the Joint DoD/DOE Munitions Technology Program are tracked and documented. In FY 2017, there were over 70 transitions to DoD weapons programs and personnel.
2. Attendance and technical interactions at the semiannual meetings of the eight Technology Coordinating Groups (TCGs) are tracked and documented.
3. Laboratory Five-Year Plans are prepared, evaluated, analyzed and approved by DOE and DoD management and technical staff.
4. TCG Chairmen's Annual Assessments for each TCG are critically reviewed by the Technical Advisory Committee (TAC) to determine progress, validate transition plans, and verify relevance of each project.
5. The five-year plans and all news start projects are approved each year by the TAC. Adjustments are made to the five-year plan based on recommendation of the TAC to meet the most compelling gaps, needs, or challenges of the DoD and the DOE.
6. Project progress toward goals and milestones is assessed at each biannual TCG meeting and critically reviewed annually by the TAC.
7. Annual technical reports, papers, and presentations are tracked and documented.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*

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	27.444	11.603	13.154	19.472	-	19.472	19.485	19.721	20.015	20.336	Continuing	Continuing
328: *Science and Technology Analytic Assessments*	27.444	11.603	13.154	19.472	-	19.472	19.485	19.721	20.015	20.336	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

This Program Element (PE) directly supports The Office of the Under Secretary of Defense, Research and Engineering (OUSD (R&E)) and OUSD Acquisition and Sustainment with assessments and analysis to inform the strategic direction of research, development, and acquisition of innovative capabilities to meet the emerging threats from the diverse range of state and non-state actors confronting the Unites States. Due to the complexity of these challenges, the process for developing and executing these analytic assessments span fiscal years and may have multiple phases.

The analysis process addresses the following Joint and Cross-Cutting missions: 1) Operational and Technical Assessments identify gaps and options to fill those gaps; 2) Technical Analysis quantifies key attributes of the challenge, assess counter technology options, and provide an operational value assessment; and 3) Development of Analytic Tools to help understand complex and longer term challenges. The Quick Reaction Analysis Team provides quick turn analysis on emerging challenges and senior leader issues using the Federally Funded Research and Development Center/University Affiliated Research Center (FFRDC/UARC) community as performers while leveraging previous related experience and work done for the Department of Defense (DoD).

Typically, the ratios of resources applied to Operational and Technical Assessments, Technical Analysis and Quick Reaction Analysis Team, and development of Analytic Tools will be roughly 30/60/10 percent. Implementation of this process could span multiple years causing the portfolio to cascade from year to year. Throughout this process the analysis will be tightly coupled with both the Intelligence community and the operational community through the Combatant Commands.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	12.048	13.154	16.676	-	16.676
Current President's Budget	11.603	13.154	19.472	-	19.472
Total Adjustments	-0.445	0.000	2.796	-	2.796
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.431	-			
• Other Program Adjustments	-0.002	-	2.927	-	2.927
• FFRDC Transfer	-0.012	-	-	-	-
• Economic Assumptions	-	-	-0.131	-	-0.131

Change Summary Explanation

The FY 2019 baseline increase of $2.927 million is to pay for higher priority DoD requirements. Funding increases support the OUSD(R&E)'s efforts to better advise the Secretary and DoD on key investments to retain technical superiority.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*	**Project (Number/Name)** 328 / *Science and Technology Analytic Assessments*

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
328: *Science and Technology Analytic Assessments*	27.444	11.603	13.154	19.472	-	19.472	19.485	19.721	20.015	20.336	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Science and Technology (S&T) Analytic Assessments Program Element (PE) directly shapes the development of innovative capabilities to meet the emerging threats from the diverse range of state and non-state actors confronting the Unites States. These areas include: space and terrestrial-based indications and warnings systems, integrated and resilient Intelligence, Surveillance, Reconnaissance (ISR) platforms, strategic lift, long-range precision strike weapons, missile defense technologies, undersea systems, remotely operated vehicles and technologies, special operations forces, the Cyber Mission Force, ground systems, and others outlined in the 2016 National Military Strategy. Due to the complexity of these challenges, the process for developing and executing these analytic assessments span fiscal years and may have multiple phases. The emerging nature of the problem sets makes specific identification of all the study projects beyond the budget year unlikely. Implementation of this process could span multiple years causing the portfolio to cascade from year-to-year.

Operational and Technical Assessments are informed by comprehensive Kill Chain Analysis (KCA) across all domains and the time continuum from 2018-2038 to identify prioritized operational issues and associated actionable technology focus areas. These products support detailed analyses and assessments to help shape technology investment decisions and inform the strategic direction of capability development Because of the 20 year timeframe, these analyses will also help to inform requirements rather than waiting for current processes to develop them. Main lines of effort include the following activities:
- KCA across Defense Planning Scenarios and other relevant DOD Vignette to identify and characterize capability disadvantages and opportunities across the battlespace.
- Developed and maintain an all source-like database of military capabilities and a standalone software application, KCA Results Display System, to provide data and analysis on operational issues.
- Produce operational impact assessments of potential technology improvements to military capabilities in the near, mid, and far term.
- Consolidate Technology focused roadmaps of US capability development and S&T developmental strategic plans.

Technical Analysis and Quick Reaction Analysis Team perform engineering level systems analysis using the DoD sponsored FFRDC/UARC and Department of Defense and Department of Energy (DoD/DoE) laboratories. Using these research performers, previously sponsored research on relevant topics is leveraged in the new research providing value and experience on new projects. Main lines of effort include the following activities:
- Technical threat assessments building on intelligence community products for identifying gaps in U.S. capability for critical threats.
- Quantitative analysis of potential new technology and concepts to address capability gaps and counter emerging threat technologies.
- Architecture development and evaluation to develop new U.S. capability.
- Independent assessment of critical capability and technology development.

Analytic Tools include modeling, simulation, and analysis (MS&A), computer based engineering models, and purposed designed equipment to demonstrate or confirm theoretical performance of technical concepts. Main lines of effort include the following activities:
- Develop analytic tools to inform and provide decision support to resourcing recommendations.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*	**Project (Number/Name)** 328 / *Science and Technology Analytic Assessments*	

- Develop strategic analytic tools enabling the analysis and evaluation of critical capability and technology development.
- Integrated MS&A leveraging Service- and Agency–level virtual and constructive resources to provide insight into complex acquisition and operational decisions.
- Red Teaming existing and planned US capabilities and weapons systems using emerging threat systems and capabilities in emerging scenarios.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Science and Technology Analytic Assessments	11.603	13.154	19.472

Description: Science and Technology (S&T) Analytic Assessments Program Element (PE) directly supports the development of innovative capabilities to meet the emerging threats from the diverse range of state and non-state actors confronting the Unites States. These capabilities include: space and terrestrial-based indications and warnings systems, integrated and resilient Intelligence, Surveillance, Reconnaissance (ISR) platforms, strategic lift, long-range precision strike weapons, missile defense technologies, undersea systems, remotely operated vehicles and technologies, special operations forces, the Cyber Mission Force, ground systems, and others outlined in the 2015 National Military Strategy. Throughout this process the analysis will be tightly coupled with both the Intelligence community and the operational community through the Combatant Commands.
In order to accomplish a balanced program of assessments, the target ratios of quick reaction studies, strategic and operational analysis, and analytic tool development is planned to be 30/60/10 percent. Accordingly, the following activities are planned for FY 2018 and FY 2019.

FY 2018 Plans:
To fully inform the analytic assessments, maintenance and expansion of the KCA analytic foundation is required each year. This will include improvements in the underlying data fidelity and breadth, and in all aspects of display, analysis, assessment, integration, entity relationships and interactions. Specific tasks that will be executed within the KCA area include:
- Continue research of new, emerging and modified Blue and Red platforms and components and integration into the KCA data environment.
- Conduct a data refresh at the platform and component level of detail to ensure the KCA database is populated with the latest intelligence and technical data.
- Update Kill Chain and Target Set assessments in support of the overall Operational Analysis within KCA.
- Continue development of threat agnostic Operational and Technical Issues and integration into the KCA environment.
- Expansion of the scope of Operational and Technical Issues into new Warfare Areas.
- Integrate Science and Technology elements (initiatives, potential solutions, technologies etc.) into the KCA environment (Operational and Technical Issues, Kill Chains, Target Sets etc.).
- Continue development, enhancements, and upgrades to the entire KCA Toolset including the KCA Results Display System.

Quick Reaction Analysis Team (QRAT):
- Quick Reaction Analytic efforts respond to critical questions related to potential vulnerabilities in current and future U.S. systems to identify opportunities or challenges related to developing foreign capabilities. These short studies typically focus on the

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*	**Project (Number/Name)** 328 / *Science and Technology Analytic Assessments*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
following capability areas: foreign, integrated air and missile defense capabilities; options for U.S. electronic warfare and capability to counter adversaries; resiliency in U.S. Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems and options to counter adversaries C4ISR capabilities; ground combat offensive and defensive capabilities, air dominance and missile defense, and undersea engagements. The QRAT is enabled by a weekly meeting of FFRDC/UARC lead contacts to review on-going and emerging tasks and collaborative technical interchanges on OUSD(R&E) and OUSD(A&S) focus areas. Technical Analysis (Strategic Studies): Strategic studies are 6-12 month engineering level systems analysis. Strategic studies parametrically define the emerging threat space, determine feasibility of potential solutions and parametrically analyze the solution trade space. Specific tasks that will be executed within the strategic studies area include: - Evaluate options to counter foreign missile capabilities. - Explore feasibility and potential of next generation electronic warfare technologies. - Characterize an architecture for theater-level electronic warfare threat awareness and battle management to effectively and efficiently apportion resource in a constrained environment. - Identify future threat detection and identification capabilities for future electronic support systems. - Evaluate threats to High Value Air Assets (HVAA) and identify potential countermeasures to develop and alternative ways to accomplish the HVAA missions. - System and technology assessments for surface and sub-surface warfare. - Evaluate options for land based defense against a missile raid. - Evaluate options for maritime based defense against a missile raid. - Evaluate efficacy of passive systems and counters to passive systems. Analytic Tools: - Develop analytic tools to inform and evaluate new technologies' potential to counter emerging threats and exploit adversary vulnerabilities from air, land, sea, and space domains. - Develop of analytic tools to provide inform and provide decision support to resourcing recommendations. - Develop integrated modeling, simulation, and analysis tools to aid complex acquisition decisions. - Develop Red Teaming methodology for evaluating US capabilities and systems in the context of emerging threats in relevant scenarios. ***FY 2019 Plans:*** Operational and Technical Assessments: Specific tasks that will be executed within the Kill Chain Analysis (KCA) area include:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*	**Project (Number/Name)** 328 / *Science and Technology Analytic Assessments*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Conduct KCA on new threat scenarios and projected threat capabilities. - Assess emerging operational scenarios against future red and blue capability timelines. - Update existing KCA based on emerging red and blue capability assessments. Quick Reaction Analysis Team (QRAT): - Quick Reaction Analytic efforts responding to critical questions related to potential vulnerabilities in current and future US systems to identify opportunities or challenges related to developing foreign capabilities. These short studies typically focus on the following capability areas: foreign, integrated air and missile defense capabilities; options for US electronic warfare and capability to counter adversaries; resiliency in US Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems and options to counter adversaries C4ISR capabilities; ground combat offensive and defensive capabilities, air dominance and missile defense, and undersea engagements. The QRAT is enabled by a weekly meeting of FFRDC/UARC lead contacts to review on-going and emerging tasks and collaborative technical interchanges on OUSD(R&E) and OUSD(A&S) focus areas. Technical Analysis (Strategic Studies): Strategic studies are 6-12 month engineering level systems analysis. Strategic studies parametrically define the emerging threat space, determine feasibility of potential solutions and parametrically analyze the solution trade space. Specific tasks that will be executed within the strategic studies area include: - Explore feasibility and potential of next generation electronic warfare technologies. - Analyze potential components of a theater-level electronic warfare threat awareness and battle management architecture. - Evaluate options to increase survivability of US weapons against advanced Integrated Air Defense System (IADS) and counter-measures - Identify and evaluate countermeasures to adversary smart weapons. - Identify and evaluate potential technologies' to aid tracking and communications for underwater operations. Analytic Tools: - Develop analytic tools to inform and evaluate new technologies' potential to counter emerging threats and exploit adversary vulnerabilities from air, land, sea, and space domains. - Develop analytic tools to provide inform and provide decision support to resourcing recommendations. - Develop integrated modeling, simulation, and analysis tools to aid complex acquisition decisions. - Red Team US capabilities and systems in the context of emerging threats in relevant scenarios. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603288D8Z / *Science and Technology (S&T) Analytic Assessments*	**Project (Number/Name)** 328 / *Science and Technology Analytic Assessments*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Expanded mission for the new USD(R&E).			
Accomplishments/Planned Programs Subtotals	11.603	13.154	19.472

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

- Critical gaps in U.S. capability are identified.
- Gaps in U.S. technology development are identified.
- New architectures and evaluation criteria for developing U. S. capability are identified.
- Analytic tools to evaluate new technologies’ potential to mitigate and counter emerging threats and exploit adversary vulnerabilities are developed.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603289D8Z *I Advanced Innovative Analysis and Concepts*

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	97.633	55.679	37.674	37.263	-	37.263	37.645	38.478	39.582	39.558	Continuing	Continuing
329: *Advanced Innovative Analysis and Concepts*	97.633	55.679	37.674	37.263	-	37.263	37.645	38.478	39.582	39.558	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Strategic Capabilities Office (SCO) identifies, analyzes, and accelerates the development, demonstration, and transition of selected capabilities to shape and counter emerging threats, and to improve U.S. security posture. In a partnership endeavor across the Office of the Secretary of Defense (OSD), Joint Staff, Combatant Commands (CCMDs), the Services, the Intelligence Community (IC), and other U.S. Government agencies, SCO combines capability innovation with concepts of operation and information management to develop novel, high-leverage approaches to address pressing national security challenges. SCO conducts projects on accelerated timelines, at any classification or access level.

The Advanced Innovative Analysis and Concepts Program Element supports development, studies, analysis, and demonstration of integrated concepts and prototypes, analysis in support of ongoing efforts to shape and counter emerging threats, cross-Service and cross-Defense/Intelligence concepts, and red-teaming. Projects focus on proving component and subsystem maturity prior to integration in major systems, and may involve risk reduction initiatives. Due to the nature of these projects, specific applications and detailed plans are available at a higher classification level.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	57.020	37.674	37.263	-	37.263
Current President's Budget	55.679	37.674	37.263	-	37.263
Total Adjustments	-1.341	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.270	-			
• FFRDC	-0.063	-	-	-	-
• Other Adjustments	-0.008	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603289D8Z / *Advanced Innovative Analysis and Concepts*	**Project (Number/Name)** 329 / *Advanced Innovative Analysis and Concepts*

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
329: *Advanced Innovative Analysis and Concepts*	97.633	55.679	37.674	37.263	-	37.263	37.645	38.478	39.582	39.558	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Strategic Capabilities Office (SCO) conducts analysis in support of ongoing efforts to shape and counter emerging threats, with special emphasis on: innovative and architecture-level concepts, cross-Service and cross-Defense/Intelligence concepts, red-teaming, and on a case-by-case basis, research and development projects to demonstrate concept. SCO identifies, analyzes, and accelerates the development, demonstration, and transition of selected capabilities to shape and counter emerging threats, and to improve U.S. security posture. In a partnership endeavor across the Office of the Secretary of Defense (OSD), Joint Staff, Combatant Commands (CCMDs), the Services, the Intelligence Community (IC), and other U.S. Government agencies, SCO combines capability innovation with concepts of operation and information management to develop novel, high-leverage approaches to address pressing national security challenges. SCO conducts projects on accelerated timelines, at any classification or access level.

The Advanced Innovative Analysis and Concepts Program Element supports development, studies, analysis, and demonstration of integrated concepts and prototypes, analysis in support of ongoing efforts to shape and counter emerging threats, cross-Service and cross-Defense/Intelligence concepts, and red-teaming. Projects focus on proving component and subsystem maturity prior to integration in major systems, and may involve risk reduction initiatives. Due to the nature of these projects, specific applications and detailed plans are available at a higher classification level.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High-Fidelity Analysis and Concept Generation ***Description:*** The Strategic Capabilities Office (SCO) conducts analysis to identify and accelerate the development, demonstration, and transition of potentially game-changing capabilities to shape and counter emerging threats and improve U.S. security posture. All innovative concepts developed within SCO must first undergo a phase of thorough analysis before moving forward to become a project. Due to the nature of these projects, specific applications and detailed plans are available at a higher classification level. ***FY 2018 Plans:*** Continue to innovate in partnership with Services Program Offices and CCMDs to identify game-changing uses of existing systems and technologies. ***FY 2019 Plans:*** Continue to innovate in partnership with Services Program Offices and CCMDs to identify game-changing uses of existing systems and technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	55.679	37.674	37.263

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603289D8Z / *Advanced Innovative Analysis and Concepts*	**Project (Number/Name)** 329 / *Advanced Innovative Analysis and Concepts*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 to 2019 decrease is a result of minor inflation rate adjustments.			
Accomplishments/Planned Programs Subtotals	55.679	37.674	37.263

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics are specific to each Advanced Innovative Analysis and Concepts effort and include measures identified in the management approach, Statement of Work (SOW), and Period of Performance (POP). In addition, completions and successes are monitored against schedules and deliverables stated in the initiative's management approach. Due to the nature of these projects, specific applications and detailed plans are available at a higher classification level

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603291D8Z / *Advanced Innovative Analysis & Concepts - MHA*

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	15.000	13.621	-	13.621	14.668	14.839	14.279	14.875	Continuing	Continuing
251: *SCO Operational Costs*	0.000	0.000	15.000	13.621	-	13.621	14.668	14.839	14.279	14.875	Continuing	Continuing

Note

This is not a new start program. Program was established in FY 2018 and funds transferred from PE 0603289D8Z / Advanced Innovative Analysis and Concepts to identify Management Headquarters Activities (MHA).

A. Mission Description and Budget Item Justification

The Strategic Capabilities Office (SCO) conducts analysis to identify and accelerate the development, demonstration, and transition of potentially game-changing capabilities to shape and counter emerging threats and improve U.S. security posture. This funding line was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts, to be used for MHA related endeavors.

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	15.000	15.000	-	15.000
Current President's Budget	0.000	15.000	13.621	-	13.621
Total Adjustments	0.000	0.000	-1.379	-	-1.379
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Other Adjustments	-	-	-1.379	-	-1.379

Change Summary Explanation

PE 0603291D8Z Advanced Innovative Analysis & Concepts - MHA, was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts and is not a new program.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			Date: February 2018
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603291D8Z / *Advanced Innovative Analysis & Concepts - MHA*	Project (Number/Name) 251 / *SCO Operational Costs*	

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
251: *SCO Operational Costs*	0.000	0.000	15.000	13.621	-	13.621	14.668	14.839	14.279	14.875	Continuing	Continuing

Note

PE 0603291D8Z Advanced Innovative Analysis & Concepts - MHA, which is not a new program was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts.

A. Mission Description and Budget Item Justification

The Strategic Capabilities Office (SCO) conducts analysis to identify and accelerate the development, demonstration, and transition of potentially game-changing capabilities to shape and counter emerging threats and improve U.S. security posture. This funding line was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts for MHA endeavors.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: SCO Operational Costs - MHA ***Description:*** The Strategic Capabilities Office (SCO) conducts analysis to identify and accelerate the development, demonstration, and transition of potentially game-changing capabilities to shape and counter emerging threats and improve U.S. security posture. This funding line which is not a new program was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts for MHA related endeavors. ***FY 2018 Plans:*** The Strategic Capabilities Office will utilize this funding for MHA related endeavors which will enable continued analysis, development, demonstration, and transition of capabilities to counter emerging threats and improve U.S. security posture. ***FY 2019 Plans:*** The Strategic Capabilities Office will utilize this funding for MHA related endeavors which will enable continued analysis, development, demonstration, and transition of capabilities to counter emerging threats and improve U.S. security posture. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease of -$1.379M in FY 2019 from FY 2018 budget numbers is due to fiscal constraints.	0.000	15.000	13.621
Accomplishments/Planned Programs Subtotals	0.000	15.000	13.621

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603291D8Z / *Advanced Innovative Analysis & Concepts - MHA*	**Project (Number/Name)** 251 / *SCO Operational Costs*

C. Other Program Funding Summary ($ in Millions)

Remarks

PE 0603291D8Z Advanced Innovative Analysis & Concepts - MHA was established in FY 2018 from transferred funds from PE 0603289D8Z / Advanced Innovative Analysis and Concepts. This is not a new program element.

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics will be specific to each of the MHA's that are funded. All of which include measures identified in the management approach, Statement of Work (SOW), and Period of Performance (POP). In addition, completions and successes are monitored against schedules and deliverables stated in the initiative's management approach.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603291D8Z / *Advanced Innovative Analysis & Concepts - MHA*	**Project (Number/Name)** 251 / *SCO Operational Costs*

Remarks

Management Headquarters Activities - MHA's that are funded under the Advanced Innovative Analysis & Concepts.

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* **/** BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603375D8Z **/** *Technology Innovation*

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	35.000	24.895	64.863	83.143	-	83.143	96.256	97.223	98.153	99.369	Continuing	Continuing
375: *Technology Innovation*	35.000	24.895	64.863	83.143	-	83.143	96.256	97.223	98.153	99.369	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) has a long history of technological breakthroughs and innovations originating from within the Department. In order to sustain technological superiority, the Department must take advantage of the rapid evolution of emerging commercial technologies that will be a source of battlefield advantage, when integrated with military systems and novel concepts of operation.

Leveraging innovative technologies from commercial startup companies has the potential to rapidly address warfighter problem sets in areas where commercial innovation outstrips government investment in the same technology areas. Through a unique partnership with other government agencies, we gain access to and vetting of innovative technologies from commercial startup companies where much of the research and development (R&D) funds are provided by the venture capital community. Small DoD investments in these companies, often in partnership with other U.S. Government agencies, further leveraging the dollars spent, provides short work programs to adapt the commercial technologies for warfighter applications. The deliverables from the work program allow the warfighters to rapidly pilot technology and concepts, with the ability to fail early and cheaply, and provide the avenue to refine warfighter requirements and transition technology from successful pilots to traditional DoD activities for integration into broader R&D efforts or acquisition programs of record.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	39.923	59.863	79.749	-	79.749
Current President's Budget	24.895	64.863	83.143	-	83.143
Total Adjustments	-15.028	5.000	3.394	-	3.394
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.000	-			
• SBIR/STTR Transfer	-	-			
• Congressional Reduction	-20.000	-	-	-	-
• Other Program Adjustments	-0.006	-	3.952	-	3.952
• FFRDC Transfer	-0.022	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603375D8Z / *Technology Innovation*

• Economic Assumption	-	-	-0.558	-	-0.558
• Prior Approval Reprogramming Action	5.000	-	-	-	-
• FY 2018 Missile Defeat and Defense Enhancements	-	5.000	-	-	-

Change Summary Explanation

FY 2017 Missile Defeat Enhancements Reprogramming (FY 17-26 PA): $+5.000 million was required to address emergency warfighting requirements in support of various classified projects. Additional details are available at a higher classification level.

FY 2018 Missile Defeat and Defense Enhancements (MDDE) Budget Amendment: $+5.000 million is required to address emergency warfighting requirements in support of various classified projects. Additional details are available at a higher classification level.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603375D8Z / *Technology Innovation*	Project (Number/Name) 375 / *Technology Innovation*

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
375: *Technology Innovation*	35.000	24.895	64.863	83.143	-	83.143	96.256	97.223	98.153	99.369	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Program focuses on three main areas: 1) Core Datahub pilot program; 2) Expansion of the Datahub pilot program to address the issues in the rest of the DoD 4+1 problem sets; and 3) Further innovation across other warfighter problem sets.

Core Datahub pilot program. This effort focuses on maturing and demonstrating the automated processing of space-based Intelligence, Surveillance, and Reconnaissance (ISR), Artificial Intelligence-driven Geospatial Intelligence (GEOINT), and Fix-Find-Finish-Exploit-Assess (F3EA) into an integrated capability to aid the Combatant Commander and Component forces in defeating threats posed by nuclear-capable, mobile missile - a problem set often plagued by sparse data. The approach is composed of three innovative building blocks: 1) Machine learning techniques applied to commercial GEOINT and other commercial data sources for automated country-wide anomaly and change detection - crucial element for enhancing indications and warnings required for precision strikes; 2) Machine-Human collaboration architecture to accelerate the F3EA joint forces targeting and decision-making cycle; and 3) Autonomous weaponeering demonstration - Exercise secure (C2S) cloud for timely precision strikes to hold mobile missile systems at risk.

Expansion of the Datahub Pilot Program. Following a successful demonstration of Datahub and its leverage of commercial data sources and automation in early 2017, the team was directed to expand Datahub to address applicable issues in the remainder of the DoD 4+1 problem sets. Some of these problem sets may leverage similar technologies to the pilot program, with data coverage for different parts of the world and algorithms tuned for different targets of interest, while other problem sets may require completely different data, algorithms, and/or technologies. Although FY 2017 funding was only 50% of what was expected, the team is executing preliminary efforts to execute the expansion when FY 2018 funds become fully available.

Innovation for other warfighter problem sets: Through the unique partnership in place for this effort, DoD is exposed to a wide variety of emerging commercial technologies which have potential applicability to a wide spectrum of DoD problem sets. Enabling the warfighter to execute short duration pilots with these evolving technologies provides a cost effective way to leverage commercial investment for DoD purposes, informing warfighter requirements for follow-on acquisition through traditional DoD channels, and allowing DoD R&D organizations to focus their resources on both the integration of commercial technologies showing promise in these warfighter pilots, and on traditional R&D in technologies not well served by the commercial start-up companies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Technology Innovation ***Description:*** The Program focuses on developing space-based Intelligence, Surveillance, and Reconnaissance (ISR), Artificial Intelligence-driven Geospatial Intelligence (GEOINT), and Fix-Find-Finish-Exploit-Assess (F3EA) into an integrated capability for defeating threats posed by nuclear-capable, mobile missile - a problem set often plagued by sparse data. ***FY 2018 Plans:*** - Finalize unclassified user-based training	24.895	64.863	83.143

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603375D8Z / *Technology Innovation*	**Project (Number/Name)** 375 / *Technology Innovation*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Test/Validate ML algorithms in Secure C2S Cloud - Transition initial prototype (UNCLAS/CLAS) to user - Test/Validate SAR ML algorithms for Airborne Assets - Demonstrate integration and validation of SAR data from airborne assets within Secure (C2C) Cloud - Development of SAR ML for space-based imagery - Test/Validate micro-SAR space assets ***FY 2019 Plans:*** - Continue Datahub expansion into the DoD 4+1 problem sets - Integrate additional commercial data sources into Core datahub and datahub expansion, as they become available. - Expand non-Datahub innovation into other warfighter problem sets. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** - This project is on a planned ramp up from ~$60M in FY 2018 to ~$80M in FY 2019 to allow this innovative approach to address a greater number of DoD problem sets.			
Accomplishments/Planned Programs Subtotals	24.895	64.863	83.143

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 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603527D8Z / *Retract Larch*

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	144.563	175.135	171.120	161.128	-	161.128	160.143	163.256	165.945	168.986	Continuing	Continuing
527: *Retract Larch*	144.563	175.135	171.120	161.128	-	161.128	160.143	163.256	165.945	168.986	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program is reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress. For further information, please contact the Director of Special Programs, OUSD(AT&L)/DSP.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	175.135	171.120	162.440	-	162.440
Current President's Budget	175.135	171.120	161.128	-	161.128
Total Adjustments	0.000	0.000	-1.312	-	-1.312
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• General Provision (FFRDC) Reduction	0.000	-	-	-	-
• Economic Adjustment	-	-	-1.312	-	-1.312

Change Summary Explanation

Factored Economic Inflation.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603527D8Z / *Retract Larch*	**Project (Number/Name)** 527 / *Retract Larch*

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
527: *Retract Larch*	144.563	175.135	171.120	161.128	-	161.128	160.143	163.256	165.945	168.986	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program is reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress. For further information, please contact the Director of Special Programs, OUSD(AT&L)/DSP.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Retarct Larch ***Description:*** Not applicable. Information Classified ***FY 2018 Plans:*** Information is classified. ***FY 2019 Plans:*** Information is classified. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Internal adjustments.	175.135	171.120	161.128
Accomplishments/Planned Programs Subtotals	175.135	171.120	161.128

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable. Classified

E. Performance Metrics

Not Applicable. Classified

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced 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	-	21.376	14.389	12.918	-	12.918	12.098	12.318	12.529	12.766	Continuing	Continuing
619: *Joint Electronic Advanced Technology*	-	10.672	11.646	12.141	-	12.141	12.098	12.318	12.529	12.766	Continuing	Continuing
245: *EW Enterprise Exploration and Innovation*	-	10.704	2.743	0.777	-	0.777	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

To counter the United States' historic technological advantage, adversaries are increasingly developing asymmetric capabilities that are enabled by advanced commercial electronic components and devices that have become globally available. These threats range from terrorist-employed improvised devices, small unmanned air systems, and easily transportable Man-Portable Air Defense Systems (MANPADS) to dedicated military systems such as advanced sensor systems, advanced Electronic Warfare (EW) components and systems, advanced Integrated Air Defense Systems (IADS), and increasingly capable cruise and ballistic missiles that can diminish our technological advantage in conflicts with nation-states.

The rate at which new threats are appearing continues to accelerate and the myriad of new advanced Electromagnetic Spectrum (EMS) threats have made operations in the EMS significantly more difficult and complex. The challenges posed by new kinetic and non-kinetic EMS threats and the dire consequences of technology surprise highlight the need to rapidly develop and field innovative EW and EW-Cyber capabilities that can rapidly address these new threats in more cost-effective ways.

The Joint Electronic Advanced Technology (JEAT) program was established to address these challenges through efforts designed to significantly accelerate the development and transitioning of new EW and EW-Cyber capabilities. To do this, the JEAT program explores, assesses, and validates a plethora of new technologies and approaches focusing specifically on technologies and approaches that fall outside the Services' Research and Development (R&D) programs or are being developed by the Services at rates that cannot not produce required capabilities in the needed timeframes to identify the most fruitful EW and EW-Cyber R&D opportunities for the Department. To identify potential nearer-term and lower-cost solutions, the JEAT program also explores and assesses approaches that integrate and demonstrate off-the-shelf military and commercial technologies in innovative ways. The JEAT program's approaches have provided substantial savings for the Services and the Department in both R&D efforts and in Programs of Record, and thus enable required military capabilities to be delivered to the warfighter much sooner than possible in traditional DoD approaches.

JEAT program efforts are focused in four areas in two Project Codes.

• In Project 619, Joint Electronic Advanced Technology, (1) the Experimentation/Demonstration effort utilizes innovative field and laboratory experimentation venues to understand current and future threats and explore potential countermeasures and overmatch opportunities, (2) the Advanced Technology Development/Verification effort explores technologies and approaches to counter advanced threats in innovative ways, and (3) the EW Collaboration and Planning effort ensures appropriate

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*

coordination and technological oversight of Department and Service EW and EW-Cyber R&D programs and processes and provides governance insights for senior decision makers.

• In Project 245, EW Enterprise Exploration and Innovation, (4) this effort explores computer-augmented data dominance and machine learning technologies, tools, and approaches to enhance awareness and accelerate planning and decision making in essential EMS war fighting capabilities.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	22.030	14.389	13.008	-	13.008
Current President's Budget	21.376	14.389	12.918	-	12.918
Total Adjustments	-0.654	0.000	-0.090	-	-0.090
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.627	-			
• FFRDC Transfer	-0.024	-	-	-	-
• Other Program Adjustments	-0.003	-	-0.003	-	-0.003
• Economic Assumption	-	-	-0.087	-	-0.087

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 619 / *Joint Electronic Advanced 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
619: *Joint Electronic Advanced Technology*	-	10.672	11.646	12.141	-	12.141	12.098	12.318	12.529	12.766	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Joint Electronic Advanced Technology project (Project 619) explores and assesses innovative technologies and approaches to rapidly mitigate advanced threats and demonstrate new overmatch technologies in ways not being explored by the Services. Project 619's three efforts, Experimentation/Demonstration (Expt/Demo), Advanced Technology Development/Verification (ATD/V), and Electronic Warfare Enterprise Collaboration and Planning (EW C&P), focus on enabling nearer-term technology transitions to the Services' Programs of Record (PoR) with reduced risk and cost. Expt/Demo efforts focus on exploring, demonstrating, and assessing innovative technologies and approaches to overcome existing and developing threats and provide new overmatch capabilities for the U.S. military. ATD/V efforts integrate advanced commercial and military off-the-shelf technologies in ways not being explored by the Services to demonstrate nearer-term technological opportunities. EW C&P efforts within Electronic Warfare and Countermeasures Office (EWCO) of the Under Secretary of Defense for Research and Engineering assess, ensure coordination, and provide senior leadership insights on all Departmental EW and EW-Cyber Research and Development (R&D) as well as coordinating national and international EW and EW-Cyber efforts.

Experimentation/Demonstration (Expt/Demo):

Expt/Demo explores and demonstrates new EW and EW-Cyber technologies and approaches through the use of large-scale, dynamic field experimentation venues. The current venue, Vigilant Hammer (VH), is a multi-year, multi-agency, live, virtual, and constructive event focused on advancing the state of the art for detecting, classifying, geolocating, and engaging of electromagnetic signals of interest. Modeled after Project 619's highly successful BLACK DART, TRIDENT SPECTRE, and Rotorcraft Aircraft Survivability Equipment Experiment (RASE) venues, VH includes both scripted and dynamic scenarios to give participants an opportunity to explore the efficacy of existing and new capabilities and approaches to engage emerging Electromagnetic Spectrum (EMS) threats. Follow-on venues will address concerns such as multi-platform/multi-aperture, collaborative/coherent EW and multistatic passive/active sensing architectures.

Advanced Technology Development/Verification (ATD/V):

ATD/V explores, matures and assesses emerging technologies and approaches to address compelling EW and EW-Cyber warfighting needs. Project 619's ongoing ATD/V effort, the Distributed Electronic Effects Development (DEED) Laboratory, explores, matures and assesses emerging EW and EW-Cyber technologies to enable, for example, multi-aperture collaborative/coherent EW and EW-Cyber employment through exquisite coordination of sensing and electronic attack capabilities.

EW Enterprise Collaboration and Planning (EW C&P):

EW C&P supports all activities of the Director, EWCO, related to the selection, organization, oversight, and coordination of all EW and EW-Cyber-related efforts across DoD. EW C&P oversees and ensures coordination and collaboration between OSD and the Joint Staff, the Combatant Commands, and the Services on all EW and EW-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 619 / *Joint Electronic Advanced Technology*

Cyber activities within DoD. To do this, EW C&P identifies, assesses, and develops recommendations to address EW and EW-Cyber-related threats impacting sensor, seeker, communications, platform survivability, countermeasures, and battle management technologies. EW C&P also provides programmatic recommendations and decision support to the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD(A&S)) on PoR, including technology maturity and availability, Critical Program Information standards, Foreign Disclosure, and Technical Signals Requirements. EW C&P also conducts and leads analyses of advanced threats and technological opportunities to support Departmental EW and EW-Cyber R&D research, development and acquisition efforts.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Experimentation/Demonstration (Expt/Demo) ***Description:*** Leveraging our history of conducting highly successful experimentation venues, our current multi-year, multi-agency, live, virtual and constructive series of field experimentation venues, Vigilant Hammer (VH), explores and assesses technologies and approaches to more effectively detect, classify, geolocate, engage, and assess actions against modern, agile and cognitive signals in a very dense and highly complex signals environment. Our next Expt/Demo venue will focus on assessing the performance of passive/active sensing architectures in a complex and congested environment. As with VH and all earlier Project 619 experimentation venues, subsequent venues will be scoped to address the most pressing EMS threats and the selection of venue topics and the scoping of these efforts will involve the EW and Cyber Communities of Interest and Executive Committees (EXCOMs) to ensure maximum relevance and benefits to Departmental efforts. ***FY 2018 Plans:*** VH 3 is planned for early third quarter of FY 2018. A report and briefing will be provided approximately two months following execution in the fourth quarter of FY 2018. Assessment of earlier VH events, compelling threats, and technological maturity is also guiding initial planning efforts of our next Expt/Demo venue which will focus on Multi-platform, Multi-aperture, Multi-domain (M3) opportunities to more effectively sense, target, and attack threats of multi-static passive/active sensing architectures in a complex and congested environment. This venue will be planned during FY 2018, and is tentatively scheduled to be held in late FY 2019. ***FY 2019 Plans:*** The new Project 619 experiment will focus on M3 and multistatic passive/active sensing and their command, control, communications and computing threat architectures. It is planned for late 2019, with a report produced and distributed approximately two months after completion of the experiment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.	2.330	5.915	6.181
Title: Advanced Technology Development/Verification (ATD/V) ***Description:*** ATD/V research efforts mature and assess emerging technologies to address compelling EW and converged EW-Cyber warfighting needs. Utilizing Project 619's DEED Laboratory, these efforts focus on identifying and integrating multiple advanced technologies to synergistically create effects that are far greater than the sum of the constituent systems and identifying	1.888	1.627	1.723

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 619 / *Joint Electronic Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
more effective and lower cost approaches to more effectively utilize, manage, and protect U.S. EMS capabilities. The DEED Laboratory integrates promising technologies into unmanned aerial vehicles managed by the Naval Air Warfare Center, Weapons Division, for further exploration and assessment in venues like VH. ***FY 2018 Plans:*** Complete the integration and enable full-operational capability of the Integrated Air Defense Systems (IADS) threat simulator in the DEED Laboratory. Develop and validate multi-platform/multi-aperture EW and Integrated Cyber Electronic Warfare (ICEW) techniques and approaches employed from distributed platforms. Continue support of advanced technique development and demonstration by multiple organizations across the DoD, including OSD and other agency-sponsored R&D efforts (Joint Capability Technology Demonstrations, Future Naval Capabilities, etc.). ***FY 2019 Plans:*** Continue to support OSD research interests in multi-platform/multi-aperture EW and ICEW techniques during the transition to a customer-funded business model. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Title: EW Enterprise Collaboration and Planning (EW C&P) ***Description:*** This effort supports the Director, EWCO in coordinating, overseeing, and managing the plethora of EMS warfare-related R&D activities across DoD for the Under Secretary of Defense for Research and Engineering. It includes maintaining cognizance of all EW capabilities and capability development activities worldwide; overseeing the all EW-related R&D activities across DoD; exploring new and innovative EMS technologies and approaches; coordinating Departmental, EW-related R&D, programs, protocols, and policy; analyzing requisite development and operational interfaces across DoD and with international partners; and reporting relevant information to top senior leaders and across the Department as well as to Congress and other external groups. ***FY 2018 Plans:*** In FY 2018, EW C&P effort will include participating in the EW EXCOM; providing guidance to and direction and management of JEAT Expt/Demo and ATD/V efforts; advancing initiatives for the establishment of EW vulnerability portfolios; and tracking the progress of Joint Urgent Operational Need SO-0010, for which Project 619 helped identify technology solutions. Project 619 continues interfacing with the Intelligence Community (IC) at senior levels to address critical intelligence gaps related to foreign EMS capabilities and advanced technology development efforts. Project 619 also assessed alternative courses of action for employing advanced, adaptive, and cognitive EW technologies that are being developed and marketed commercially for data communications, radar, and other advanced spectrum domains previously dominated by DoD. Emerging concepts and	6.454	4.104	4.237

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 619 / *Joint Electronic Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
technologies from the R&E Reliance Process and the EW Science and Technology Community of Interest road maps were assessed for their potential impact and value. Analysis and coordination of national and international efforts addressing emerging Information Operations and EW-Cyber Convergence topics were addressed as well as efforts to advance technologies that provide countermeasures to imaging infrared seekers and expand U.S.-Australia collaboration in EW-Cyber. These efforts guided planning of Non-Kinetic Battle Management and Visualization Technology research efforts in Project 245 of this Program Element. In addition to continued participation in ongoing efforts mentioned above, FY 2018 efforts include the development of a variety of new EW capabilities including distributed cooperative or coherent aperture techniques; battle management and visualization technologies for optimization of non-kinetic fires; asymmetric targeting technologies; passive system countermeasure techniques; and national technical means applications to EW. Efforts will also guide planning of future EW Enterprise Exploration and Innovation (Project 245) research efforts. ***FY 2019 Plans:*** In addition to previous, ongoing efforts, FY 2019 efforts will focus on the development of a variety of new EW-Cyber integrated and coordinated capabilities, the transition of new battle management and visualization technologies for optimization of non-kinetic fires; the exploration of new multi-platform/multi-aperture engagement technologies, and the exploration of new technologies and approaches to engage passive/active sensing architectures, and the fuller leveraging of national technical means to enhance EW and EW-Cyber capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Accomplishments/Planned Programs Subtotals	10.672	11.646	12.141

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 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 245 / *EW Enterprise Exploration and Innovation*

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
245: *EW Enterprise Exploration and Innovation*	-	10.704	2.743	0.777	-	0.777	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

The EW Enterprise Exploration and Innovation project (Project 245) started in FY 2016 to accelerate the development of innovative technologies and approaches to (1) provide countermeasures to new classes of advanced EW threats, (2) provide new EW-Cyber capabilities, and (3) enable extremely high fidelity, real-time comprehension and control of the EMS battlespace and the effects of non-kinetic attack tools within it. Four efforts were initiated to address these objectives, and one is ongoing. The Advanced Airborne Countermeasures Development and Advanced Defensive Countermeasures Development efforts addressed Area 1 and the Advanced EW and EW-Cyber Exploration/Development effort addressed Area 2 above. The current ongoing effort, Non-Kinetic Battle Management and Visualization Technology Development addresses Area 3.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Airborne Countermeasures Development ***Description:*** This classified effort will mature and demonstrate an advanced countermeasure to a new class of missile seeker threats which have expanded spectral and temporal coverage and resolution. Leveraging earlier Service efforts, the products of this effort will be integrated into existing countermeasure architectures for effectiveness assessment and enable the earlier transition of countermeasure capabilities to the warfighter. This effort formally ended in FY 2017, but late receipt of ordered equipment will delay completion of this effort into FY 2018 utilizing FY 2017 funding (no additional funding is required).	3.496	-	-
Title: Advanced Defensive Countermeasures Development ***Description:*** This two-year classified effort commenced in FY 2016. It will develop and assess the efficacy of a new approach to defend naval assets against advanced threat weapons employing increasingly sophisticated seeker technologies. Significant leveraging of existing countermeasure approaches will be emphasized with the objective of demonstrating the efficacy of this approach in a realistic field environment. While this effort formally ended in FY 2017, late receipt of equipment is delaying the maritime test event until second quarter of FY 2018, followed by analysis and comparison with modeling and simulation results (no additional funding is required).	0.775	-	-
Title: Non-Kinetic Battle Management and Visualization Technology Development ***Description:*** Non-Kinetic Battle Management and Visualization Technology Development explores a variety of advanced technologies to include legacy EMS Battle Management (BM) tools and IC capabilities and state-of-the-art ‘big data’ analytics, visualization and novel human-machine interface technologies to significantly enhance the fidelity, timeliness and comprehensibility of information provided to warfighters and IC analysts responsible for understanding and exercising control of	5.585	2.743	0.777

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 245 / *EW Enterprise Exploration and Innovation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
the EMS and cyberspace warfighting domains. Leveraging state-of-the-art algorithmic-driven processing, artificial intelligence, machine learning, and autonomy support, predictive analytics will be developed to enable course of action development for the highly accurate, precise and timely employment of non-kinetic capabilities within the electromagnetic and cyberspace warfighting domains. ***FY 2018 Plans:*** Building on FY 2017 efforts, the initial demonstration of Digital Attack Surface Execution Environment (DASEE) capabilities is scheduled for December 2017 and the final demonstration for Phase One activities is scheduled in February 2018. FY 2018 efforts will significantly expand and refine approaches to increase the representational fidelity and comprehensibility of non-kinetic battlespaces and advance course-of-action development capabilities. Operational and IC users will be highly leveraged in this work to refine initial products and streamline the transitioning of newly developed capabilities to users for field experimentation and assessment. ***FY 2019 Plans:*** DASEE research effort will continue with two additional demonstrations involving progressively more challenging objectives culminating with field demonstrations for operational and IC users to enable the transition of DASEE capabilities to these communities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 adjustments are reflective of higher priority DoD requirements.			
Title: Advanced EW and EW-Cyber Exploration/Development ***Description:*** This task will work on access and payload capability for EMS-cyberspace capabilities for closed network access and effects against hard-to-reach targets in Anti-Access/Area Denial (A2/AD) environments. This initiative focuses on the continuum between EW effects, such as jamming, and Cyber effects to produce greater military impact against potential adversaries. It will also develop and integrate advanced algorithms, signal processing, and techniques for increasing the viable standoff distance for non-kinetically interrogating, engaging, and disrupting of adversary threats. This effort was completed in FY 2017.	0.848	-	-
Accomplishments/Planned Programs Subtotals	10.704	2.743	0.777

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 245 / *EW Enterprise Exploration and Innovation*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*

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	731.504	127.961	105.871	106.049	-	106.049	107.666	110.260	112.417	114.595	Continuing	Continuing
648: *Joint Capability Technology Demonstration (JCTD)*	731.504	127.961	105.871	106.049	-	106.049	107.666	110.260	112.417	114.595	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The Joint Capability Technology Demonstration (JCTD) program addresses Joint and Combatant Commands (CCMDs) warfighting needs through the execution and demonstration of prototypes within two to four years of the identification of a need. The program delivers developmental and operational prototypes to the field for military utility assessment (MUA) to affordably operationalize technologies that enable warfighters to explore novel concepts and to facilitate informed transition to formal programs of record (PoR) when appropriate. Based on the results of the assessments, performed under the cognizance of a CCMD sponsor, the products of a JCTD are either “left behind” for additional assessments or operational use, transition to a PoR, or returned to the technical baseline inventory.

The key tenets of the program are in alignment with the new Under Secretary of Defense for Research and Engineering USD(R&E) guiding principles to: shape major technology investments within DoD, focus on joint and cross-cutting missions, prove new concepts of operation, inform and or validate requirements, leverage open systems architectures, and identify accelerated paths to acquisition.

The JCTD program achieves this by engaging the interagency, international, and non-governmental partners to expand the Department of Defense's (DoD) access to innovation. It serves as the vehicle for CCMDs to address Joint strategic priority areas that present significant risk and suffer from inadequate investment, which often fall into the seams between the military Services and DoD agencies. JCTD investments are informed by the CCMDs’ integrated priority list, the capability gaps assessment provided by the Joint Staff, and the Military Services' science and technology roadmaps.

In FY 2017, the JCTD program successfully completed the MUA and transition of several JCTD prototypes that fielded affordable and sustainable solutions to meet immediate operational needs.

MEASURABLE OUTCOMES:

• The JCTD Program has executed 113 JCTDs from FY 2006 to present. The data shows a transition rate for the program of 81 percent with 52 percent of capabilities transitioning to a PoR, 25 percent to operational fielding, and 4 percent to General Services Administration (GSA) schedule. The remaining 19 percent were returned to the technical base for further development or were terminated. Overall, the JCTD program has directly supported multiple key operations while rapidly accelerating game changing technology/capabilities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	148.184	105.871	106.798	-	106.798
Current President's Budget	127.961	105.871	106.049	-	106.049
Total Adjustments	-20.223	0.000	-0.749	-	-0.749
• Congressional General Reductions	-16.000	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-4.056	-			
• FFRDC Transfer	-0.145	-	-	-	-
• Other Adjustments	-0.022	-	-0.037	-	-0.037
• Economic Assumption	-	-	-0.712	-	-0.712

Change Summary Explanation

FY 2017 congressional reduction of $16.000 million is to maintain program affordability.

FY 2019 baseline decrease is being applied to fund other DoD requirements and priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*	

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
648: *Joint Capability Technology Demonstration (JCTD)*	731.504	127.961	105.871	106.049	-	106.049	107.666	110.260	112.417	114.595	Continuing	Continuing

A. Mission Description and Budget Item Justification

JCTD projects selection is driven by their ability to accelerate transition of new capabilities to the warfighter; strong Combatant Command and Joint Force interest; cost share commitments from the Military Services and Defense Agencies; mature technical readiness; and a well-defined and affordable transition path for long term sustainment. Focus areas within the current selection cycle include: electromagnetic spectrum maneuver; intelligence, surveillance and reconnaissance (ISR) and counter-ISR; asymmetric force application; and, information operations and analytics.

The final objective for the JCTD program is to maintain United States (U.S.) technological superiority across the range of military operations while reducing the cost of operations, facilitating joint interoperability, and allowing for the rapid insertion of new capabilities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Low Cost Cruise Missile (LCCM)	5.000	5.000	5.000

Description: Previously funded JCTD. LCCM provides a decentralized autonomy capability for low-cost, conventional air-launched cruise missiles that will enable joint access and maneuver in the global commons. It will be capable of conducting networked integrated attacks, in-flight dynamic retargeting/reallocation and synchronized cooperative/saturation attacks. Flight demonstrations will be conducted using surrogate weapon platforms and will provide residual leave-behind payloads for transition to a full weapon system development program. FY 2017 funds were used to begin production of LCCM air vehicles. Additional resources were provided by the U.S. Air Force Research Laboratory and the Office of Naval Research.

FY 2018 Plans:
Continue producing prototype LCCM vehicles. Develop and refine the autonomy module's ability to sense the environment and execute counter measures based on Commander's intent or rules of engagement. Complete required program management documentation and planning for the joint military utility assessment (MUA). Coordinate management activities for initial delivery of six-inch diameter vehicles in early FY 2019.

FY 2019 Plans:
Conduct surrogate weapon operational demonstrations of ingress formations. Pending successful operational demonstrations and military utility assessments (MUA), LCCM will provide residual leave-behind autonomy payloads for transition to a full weapon system development program under U.S. Air Force sponsorship.

FY 2018 to FY 2019 Increase/Decrease Statement:

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
None			
Title: Low Cost Missile Defeat (LCMD) ***Description:*** Previously funded JCTD. Low Cost Missile Defeat (LCMD) is a ballistic missile defense system designed to counter current and emerging weapons of mass destruction (WMD) and anti-access/area denial (A2/AD) threats. LCMD program execution has been structured using a building block approach; the FY 2015 step was a technology demonstration effort under the Deputy Assistant Secretary of Defense, Emerging Capability & Prototyping (DASD (EC&P)) to accelerate technology maturation. The concept of operations (CONOPS) for the system has been formulated to integrate LCMD into the existing National Ballistic Missile Defense (BMD) architecture and will prioritize the use of existing components and systems already fielded. LCMD is not designed as a replacement to existing BMD systems, but rather as a lower cost complementary/augmentative component to forward-deployed BMD assets. The LCMD capability would augment current BMD systems and mitigate threat vulnerabilities to U.S. personnel and strategic assets. Funding was allocated for participation in the Missile Defense Agency (MDA) Low Cost Interceptor Study (LCIS) and risk reduction for key technologies, including the seeker and thrust vane subsystems, modeling and simulation of subsystem design capabilities, and limited prototyping for component flight boards and gimbals. Results from the LCIS indicated there are more cost effective and viable options for a low cost interceptor. Accordingly, DoD discontinued the LCMD program and saved the intellectual property and data package for future BMD development efforts. The LCMD JCTD was closed out in late FY 2017.	3.400	-	-
Title: Military Application of the Space Environment (MASE) ***Description:*** Previously funded JCTD. MASE demonstrated mature space environment technology to improve combat operations. The prototype provided weapons system specific visualizations that can be integrated into operational plans and tactics, techniques, and procedures as decision aids to assess their utility for mission operations. Products were evaluated using quantitative standard measures of performance, effectiveness, and outcome against theater operational requirements. In FY 2017, MASE completed the final military utility assessment and provided a leave behind residual capability to U.S. Pacific Command for operational use. MASE transitioned to Air Force Space Command Program of Record for extensive distribution and technical advancements for the Combatant Commands. The MASE JCTD was completed in FY 2017.	3.086	-	-
Title: Port Improvement via Exigent Repair (PIER) ***Description:*** Previously funded JCTD. PIER will deliver a dynamic, agile, cost effective (non-military construction) expeditionary engineering solution to rapidly repair damaged or degraded ports to a minimum level of serviceability after an attack or natural disaster. Agility is achieved through a smaller footprint, commercial off-the-shelf infusion, and quick reaction of theater-based repair assets (e.g., pre-packaged, pre-positioned). The intent of PIER is to assure continued logistics resiliency and freedom for U.S. Forces to maneuver and conduct agile strategic sealift and logistics. PIER will allow the Department of Defense to address the doctrine, organization, training, materiel, leadership, personnel, facility, and policy (DOTMLPF+P) concerns about its ability to	2.608	2.104	0.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
conduct rapid port damage repair. The plan is to transition to the U.S. Army, U.S. Navy, and U.S. Transportation Command in FY 2019. ***FY 2018 Plans:*** Conduct a limited operational demonstration of the pile bracing/bridging and mooring technologies. Conduct a technical demonstration on the Pier Overdecking System (PODS). These technologies allow secondary components to strengthen the superstructure of the ports. Refine and validate superstructure technologies based on lessons learned from earlier demonstrations: pile capacity upgrade, pile bracing, pile cap repair, beam replacement, beam and cap upgrade. Continue to plan transition to U.S. Army, U.S. Navy, and the U.S. Transportation Command. ***FY 2019 Plans:*** Conduct final military utility assessment of PIER technologies in cooperation with U.S. Transportation Command, U.S. Navy, and U.S. Army. Transition components to the U.S. Transportation Command, U.S. Navy, and U.S. Army. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding decreased in FY 2019 because the JCTD will be completed in FY 2019 and will transition to the U.S. Transportation Command, U.S. Navy, and U.S. Army.			
Title: Small Satellite Communications Network (SSCN) ***Description:*** Previously funded JCTD. SSCN provides an adaptive, self-healing, full-mesh network for assured communications, using a proliferated constellation of low-earth orbit satellites and advanced software defined radios. In FY 2017, SSCN completed a full system architecture design and initial laboratory testing of high risk subsystems. SSCN conducted initial testing and demonstration readiness reviews and delivered design documentation to a classified user. Details are classified.	4.000	-	-
Title: Ravenscraig ***Description:*** Previously funded JCTD. Ravenscraig will provide technical and operational characterization and countermeasures for a class of threat signals. Details are classified. Capability transitioned to the U.S. Air Force and the Defense Intelligence Agency.	3.000	-	-
Title: Combatant Commander (CCMD) Support, Transition Enabling and Strategic Project Operational Management ***Description:*** Previously funded effort. This effort is comprised of three programs that support the entire JCTD Program, separate from the specific JCTD projects. The three programs are (1) Unified CCMD Direct Support, (2) JCTD Pre-Transition and (3) Program Integration Office for execution of select, classified projects. (1) CCMD Direct Support: The CCMDs are essential in specifying capability needs, project development, demonstration, military utility assessment, and transition of JCTDs. The JCTD Program provides direct support to CCMDs enabling the CCMDs to provide an on-site JCTD operational manager. (2) JCTD	23.000	24.000	25.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Pre-Transition: In some cases, Service or Agency partner transition funding is not available for one to two years following the JCTD assessment phase. In such cases, where there is a clear transition and the need to sustain the capability for a short time prior to availability of Service or Agency transition funds, the JCTD Pre-Transition fund may be used to meet that need. (3) Program Integration Office: Executes a select number of classified projects in areas such as electronic miniaturization, electronic countermeasures, advanced mobile ad hoc network communications, space situational awareness (SSA) intelligence surveillance and reconnaissance (ISR), sensor platforms and communications, and persistence surveillance. ***FY 2018 Plans:*** Continue to provide CCMD direct participation to enable CCMD staff participation in developing and executing projects selected as a result of the technology assessment panels. Sustain selected projects until program of record funds are received. Execute a limited number of classified projects' military utility assessments. ***FY 2019 Plans:*** Continue to provide CCMD direct participation to enable CCMD staff participation in developing and executing developmental and operational prototypes. Develop and execute projects selected as a result of the technology assessment panels. Sustain selected projects until program of record funds are received. Execute a limited number of classified projects' military utility assessments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase reflects a modest adjustment for inflation.			
Title: JCTD Concept Development/Developmental and Operational Prototypes ***Description:*** Previously funded effort. The JCTD program will develop projects as operational prototypes to address broader Defense strategic initiatives in areas such as asymmetric force application, electromagnetic spectrum maneuver, information operations and analytics and intelligence, surveillance, and reconnaissance (ISR) and counter-ISR. Selected projects will leverage networks within the global research and engineering enterprise to include government labs and integration facilities, depots, academia, as well as traditional and non-traditional providers. Prototypes will utilize best practices to satisfy joint and cross-cutting needs. The JCTD office will work with the Services to identify means to streamline prototype transition into the acquisition systems where appropriate. ***FY 2018 Plans:*** Select advanced prototyping activities as new starts in FY 2018 in the following four (4) focus areas: - Asymmetric Force Application: The use of non-traditional technologies and symmetric approaches to provide a clear military advantage in protection, maneuver, and engagement.	24.601	31.327	52.082

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
- Electromagnetic Spectrum Maneuver: The use of technologies to maneuver freely in the electromagnetic spectrum for offensive and defensive operations across multiple domains, e.g., air, maritime, land, and space. - Information Operations and Analytics: Efficiently and accurately exploit information collection and analytics technologies for seamless processing, exploitation, and dissemination of all-source data and information as well as multi-domain command and control across Services, Combatant Commands, and partner forces. - Intelligence, Surveillance, and Reconnaissance (ISR) and Counter-ISR: Enhance the effectiveness of strategic integration of ISR capabilities as a force multiplier to provide decision makers with fused, actionable data and intelligence, and to deny the adversary ISR capabilities. ***FY 2019 Plans:*** Fund the follow-on efforts for projects started in FY 2017 and new projects selected to start in FY 2018. Select advanced prototyping activities as new starts in FY 2019 in the following four (4) focus areas: - Asymmetric Force Application: The use of nontraditional technologies and symmetric approaches to provide a clear military advantage in protection, maneuver, and engagement. - Electromagnetic Spectrum Maneuver: The use of technologies to maneuver freely in the electromagnetic spectrum for offensive and defensive operations across multiple domains, e.g. air, maritime, land, and space. - Information Operations & Analytics: Efficiently and accurately exploit information collection and analytics technologies for seamless processing, exploitation, and dissemination of all-source data and information as well as multi-domain command and control across Services, Combatant Commands (CCMD), and partner forces. - Intelligence, Surveillance, and Reconnaissance (ISR) and Counter-ISR: Enhance the effectiveness of strategic integration of ISR capabilities as a force multiplier to provide decision makers with fused, actionable data and intelligence, and to deny the adversary ISR capabilities. These focus areas may be updated based on evolving CCMD needs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Element baseline increases from FY 2018 to FY 2019. This project area shows a rise in funding from FY 2017/FY 2018 into FY 2019. The reason for the increase is because, during the years of execution (FY 2017/FY 2018), projects are selected, funded and displayed separately in this R-2, thus reducing FY 2017/2018 funding in this focus area. The reality is that total funding supporting this focus area is level to slightly up.			
Title: Enabling Technologies (ET) ***Description:*** The ET funds are used to assess or mature emerging capabilities that support the initiation of a developmental or operational prototype. ET investments are small (average $0.500M), short (less than one year) efforts that may lead to a prototype, depending on the final assessment and determination of technical maturity. Examples of ETs funding in FY 2017 include: 1) The Autonomous Mission Package Planning and Execution (AMPEE), a risk reduction effort for a FY 2017 autonomy	8.000	8.000	8.000

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
focused JCTD. AMPEE demonstrated a mission planning system and the ability to conduct cognitive netted distributed electronic warfare on multiple class unmanned aerial systems. 2) Scanning Infrared Sensor for Unmanned Air Vehicle Detection and Tracking (SISUDT), a prototype fixed-site, multi-sensor counter-unmanned aerial system (C-UAS) to detect, track, and identify group one and two UASs near forward operating bases. One SISUDT prototype was deployed in support of Operation Inherent Resolve for an in-theater validation of infrared UAS detection. 3) Strike Awareness for Gray Zones (STAGE) a risk mitigation effort to address shortfalls in the STAGE JCTD proposal by defining a management structure, technical approach, and transition plan for the effort. ***FY 2018 Plans:*** Projects will continue to be used to assess or mature emerging capabilities that support the initiation of developmental or operational prototypes. Selected efforts will be small, focused, and executable in less than one year and require a concrete deliverable prototype hardware and/or software, integrated subsystem or technology assessment report, etc. ETs will be derived from the technical assessment panels that assess JCTD proposals. ***FY 2019 Plans:*** Projects will continue to be used to assess or mature emerging capabilities that support the initiation of developmental or operational prototypes. Selected efforts will be small, focused, and executable in less than one year and require a concrete deliverable prototype hardware and/or software, integrated subsystem or technology assessment report, etc. ETs will be derived from the technical assessment panels. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change in funding profile.			
Title: Assured Command and Control using Emerging Nanosat Technology (ACCENT) ***Description:*** Previously funded JCTD. ACCENT places an adaptive filter algorithm into a nano-satellite receiver to mitigate radio frequency interference. ACCENT rapidly integrates the filter into a number of radios with an optional path to test in space using existing nano-satellite radios. In FY 2017, ACCENT optimized adaptive algorithm and radios as needed to meet on-orbit performance goals. ***FY 2018 Plans:*** Incorporate and integrate adaptive algorithms and radio modifications to improve performance. Test filter-algorithm in space with the integrated communications extension capability nano-satellite constellation. Produce on-orbit test results and military utility assessment reports. Plan to transition to Navy Program Executive Office for Space Systems Science and Technology. The	0.850	0.400	-

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
filters will be uploaded onto existing Prometheus satellites. ACCENT receives partner funds from the Office of Naval Research. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Project will complete in FY 2018.			
Title: High-altitude Attritable Link Offset (HALO) ***Description:*** Previously funded JCTD. HALO uses high altitude, low-cost balloons as communication relays in denied environments. It accomplished this by using the ultra-high frequency (UHF) radio frequency spectrum and techniques that allow non-attribution to the source of the UHF signals. The advanced technology resides at the user terminals on the ground, which receive data from the balloon-platforms, and subsequently perform the processing and communication receiver functions that allow effective two-way communication in a contested environment. HALO received partner funds from U.S. Air Force Air Combat Command and U.S. Air Force Life Cycle Management Center. In FY 2017, HALO completed the development of the hardware and software payloads for the balloons. ***FY 2018 Plans:*** Conduct laboratory testing of the payload and algorithms. Complete the development of the ground control station. Refine the adaptive beam-forming algorithm to enable handling of doppler radar spread, delay spread, gain control, phase noise, and computational complexity. Conduct flight demonstrations in a non-contested environment. Perform extended testing and military utility assessment. Complete the concept of operations. Successfully conduct a flight demonstration in a contested environment. Transition to U.S. Marine Corps program office for production acquisition contracts. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Project will complete in FY 2018.	4.910	4.340	-
Title: Gunsmoke-J (Note: Name changed from Jacob's Ladder) ***Description:*** Previously funded JCTD. Name changed from Jacob's Ladder. Gunsmoke-J uses emerging advanced electronics to allow the use of dedicated intelligence assets to provide tactically actionable targeting data to warfighters on a responsive and persistent timeline. This significantly improved reaction times and provided greatly enhanced targeting information for warfighters. In FY 2017, Gunsmoke-J completed development of system requirements and associated flow down to the component level, finalized the threat set, and developed a risk register. ***FY 2018 Plans:*** Conduct mission performance analyses and develop cubic satellite (CubeSat) system designs. Develop an initial data dissemination architecture. Prepare a concept of operations and evaluation plan for a military utility assessment (MUA). Complete CubeSat system assembly, integration and test work, and finalize the dissemination ground segment. Conduct a critical	4.660	2.500	-

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
design review, flight readiness review, and deliver three flight units to the launch provider for integration and launch. Install three ground stations for the MUA to be conducted by U.S. Pacific Command (USPACOM). Transition residuals to USPACOM for operational use and sustainment by U.S. Army Intelligence, Electronic Warfare and Sensors program office. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Project will complete in FY 2018.			
Title: India Science and Enabling Technology Focus Area ***Description:*** The India Science and Enabling Technology (S&T) Focus Area is a Secretary of Defense directed project designed to deepen and streamline defense cooperation between the U.S. and India. By sharing research resources, capabilities, and expertise, the United States and India can jointly develop technological innovations needed to enable our defense industrial bases to support our militaries now and in the future. Further, development of vibrant S&T cooperation is a key step in building an enduring partnership. India Science & Technology baseline funding transfers to Emerging Capabilities Technology Development, Program Element 0603699D8Z in FY 2018 to enable proper alignment and execution of the effort.	7.480	-	-
Title: Atmospheric Propagation of High Energy Lasers (APHL) ***Description:*** Previously funded JCTD. APHL is a joint U.S. - India JCTD that developed new atmospheric propagation models and compensation techniques to maximize high energy laser propagation in urban atmospheric conditions. It characterized the atmosphere in five categories: aerosol scattering, molecular absorption, thermal blooming, deep turbulence, and refraction. These characteristics of the atmosphere are important in urban environments due to the effects they will have on laser propagation and power on target for military applications. The U.S. Navy also contributed funds to support APHL activities.	0.260	-	-
Title: Improving Cognitive Models and Artificial Cognition ***Description:*** Previously funded JCTD. This project is a joint U.S. - India JCTD that will create architectures and modules that monitor and predict fatigue, provide new interaction capabilities, and allow autonomous systems to learn through interactive tasks. The overall architecture, which will use a combination of adaptive control of thought—rational and logic architecture will be demonstrated on two separate tasks: finding people and finding objects. The goal is to build the basic level architecture to learn how to find people and objects by improving embodied cognition, human robot interaction, and interactive task learning. In FY 2017 computational cognitive models for embodied cognition, human-robot interaction, and interactive task learning were developed. Experiments were conducted on autonomous systems to find people and objects in different environments. Transition is targeted for the U.S. Marine Corps Warfighting Lab, U.S. Navy Explosive Ordinance Disposal Technology Division, U.S. Special Operations Command, U.S. Border Protection, and the India Defense Research Development Organization.	2.260	-	-
Title: Brilliant Effects Employment Shadow (BEES)	6.000	5.000	5.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: FY 2017 new start. BEES will demonstrate finding, fixing, tracking, and targeting of mobile targets using cooperative, multi-modal intelligence surveillance and reconnaissance (ISR) and electronic warfare (EW) sensors on autonomous, unmanned aerial systems (UAS). BEES will demonstrate autonomous behaviors to synchronize multiple ISR and EW platforms that responsively find and track moving high value targets, and update manned strike/command and control platforms operating out of threat range. In FY 2017, BEES produced key project management documents, operational scenarios, and readied vehicles and components to support project goals. ***FY 2018 Plans:*** Begin flight demonstrations of UAS required behaviors. Fight demonstrations of EW and ISR autonomous actions. Continue laboratory testing of integrated EW and ISR payloads to include cooperative autonomous behaviors. ***FY 2019 Plans:*** Conduct a joint military utility assessment of autonomous EW and ISR behaviors as part of an integrated mission package in an operationally representative environment. Transition the capability in coordination with the Air Force Life Cycle Management Center (AFLCMC) Fighter Bomber Program Office to a Service program of record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** JCTD provided BEES $6.000 million in the first year to accelerate development followed by a decrease to $5.000 million per year in FY 2018 and FY 2019. This is a planned decrease in funding.			
Title: Mobile Unmanned Air Vehicle Distributed Lethality Airborne Network (MUDLAN) ***Description:*** FY 2017 new start. MUDLAN will augment current military communication systems by enabling persistent, networked battlespace using airborne high data rate nodes that provide robust air, land, and sea connectivity in contested environments. MUDLAN networks will support over-the-horizon coordinated command and control, voice communication, and intelligence, surveillance, and reconnaissance for air and surface forces. In FY 2017, MUDLAN conducted a communications requirements study to determine network connectivity needs and completed a modeling and simulation study of tactical connections between air, ground, and seaborne assets. ***FY 2018 Plans:*** Complete detailed design of communications nodes for air, land, and sea platforms and conduct critical design reviews. Integrate communications systems into host platforms and develop initial flight test plans. Target transition to the U.S. Air Force Air Combat Command. ***FY 2019 Plans:***	1.000	2.800	2.600

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Perform flight testing on air, land, and sea platforms to demonstrate military utility of high data rate communications nodes. Incorporate test platforms in additional operational experiments to demonstrate over-the-horizon, distributed communications capabilities at scale. Transition the technologies to a U.S. Air Force Air Combat Command Program of Record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding decreases in FY 2019 because the primary design, testing, and integration will have concluded. Operational testing and transition efforts will be supported by increased partner organization funding.			
Title: Pseudolite Synthetic Aperture Radar (PSAR) ***Description:*** FY 2017 new start. PSAR will develop a small form-factor synthetic aperture radar (SAR) to provide all weather intelligence, surveillance, and reconnaissance (ISR) from a high altitude (pseudolite) platform. The system will provide high ground resolution, while minimizing size, weight (7 pounds objective) and power (less than 200 watts objective). The capability will be demonstrated on the high altitude long endurance (HALE) unmanned aerial system (UAS), a surrogate pseudolite to be loaned by the United Kingdom Ministry of Defense (UK MoD). In FY 2017, PSAR designed and fabricated antennas and power amplifiers for two SAR prototypes. ***FY 2018 Plans:*** Fly prototypes on surrogate manned aircraft. Repackage prototypes to meet pseudolite platform space, weight, power and cooling constraints. Integrate a down-link communications system for transfer of SAR data. Complete integration of SAR prototypes on pseudolite aircraft. Perform operational demonstration and military utility assessment. Transition to U.S. Navy Program Executive Office, Space. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Project completed in FY 2018.	6.050	2.150	-
Title: Predictive Human Intelligence (HUMINT) Crisis Model (PICK'EM) ***Description:*** FY 2017 new start. PICK'EM will provide U.S. Special Operations Command, U.S. Africa Command, and the Defense Intelligence Agency the capability to identify crisis events and provide countermeasures that will inform U.S. policy makers. In FY 2017, PICK'EM specified the system design and built an experimental test bed utilizing live data processing to solve critical DoD missions. ***FY 2018 Plans:*** Deliver a prototype test-bed, source code, and data sets. Ingest live data from multiple sources. Conduct system level testing, security validation, and system accreditation. Deliver live operational prototype that use live scenarios. ***FY 2019 Plans:***	3.200	3.000	3.800

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Validate prototype using live scenarios. Deliver PICK'EM capability. Conduct operational demonstrations and the military utility assessment. Transition PICK'EM to the Intelligence Community, U.S. Special Operations Command, and U.S. Africa Command. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2018 to FY 2019 increase is based on additional capabilities being added to the live operational prototype prior to the military utility assessment.			
Title: Quickstrike MK64 – Extended Range (QS64-ER) ***Description:*** FY 2017 new start. QS64-ER will integrate the in-service 2,000 pound Mark 64 maritime mine, the in-service KMU-55 guidance kit, a prototype wing kit, and guidance software to allow maritime mines to be deployed from a B-52 aircraft to a precise location, in a single pass, from a safe stand-off distance. In FY 2017, QS64-ER developed guidance software and demonstrated aircraft integration and verification of airworthiness on a B-52 aircraft. ***FY 2018 Plans:*** Demonstrate external release of QS64-ER from a B-52. Demonstrate glide performance of wing kit and accuracy of guidance unit. Perform a military utility assessment of hydrodynamic effects on mine placement accuracy and survivability of water impact. ***FY 2019 Plans:*** Perform analysis of results, transition planning, and produce final report. Transition to U.S. Navy joint direct attack munition program of record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding decrease for FY 2019 due to aircraft integration, hydrodynamic analysis, and weapon demonstration being completed in 2017 and 2018.	3.771	3.750	1.067
Title: Talon Tactical Mobile Over-the-Horizon Radar (TACMOR) ***Description:*** FY 2017 new start. TACMOR will support air domain awareness and maritime domain awareness requirements over the Western Pacific region. The project will demonstrate a sub-scaled over-the-horizon radar (OTHR) that is one quarter the size of traditional OTHR systems. In FY 2017, TACMOR designed and fabricated transmit/receive enclosures, fabricated transmit/receive arrays, and integrated system components with partner nations. ***FY 2018 Plans:*** Conduct critical design reviews, factory tests, and a military utility assessment of the system. Install the OTHR system at the site using partner funding. Integrate the system with other intelligence, surveillance, and reconnaissance assets. Develop system and training documentation. Transition the system to the U.S. Air Force and complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	5.000	5.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Project will complete in FY 2018.			
Title: Semi-Automated Counter-Propaganda Platform (SCP) ***Description:*** FY 2017 new start. SCP will provide U.S. Central Command, U.S. Special Operations Command, U.S. Southern Command, and U.S. Pacific Command the ability conduct critical Military Information Support Operations (MISO) at an unparalleled scale. ***FY 2018 Plans:*** Deliver two technical demonstrations, initial concept of operation, and training. Deliver SCP capability. Conduct the military utility assessment and transition SCP to U.S. Special Operations Command's Media Production Center family of systems. The MISO Operations Command under the control of the U.S. Special Operations Command's provide MISO support functions to all Combatant Commanders. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Project completed in FY 2018	2.325	3.500	-
Title: Wingman ***Description:*** FY 2017 new start. Wingman will utilize unmanned ground vehicles (UGV) to project lethality that can maneuver effectively with a mounted formation and engage ahead of and along with manned platforms. The integration of weaponized UGVs into combat elements will provide initial operational stand-off for manned vehicles, enhanced situational awareness, and mitigate the risk of casualties at first contact. In FY 2017, Wingman conducted an initial operational demonstration with live-fire testing, and drafted Wingman concept of operations and tactics, techniques, and procedures. ***FY 2018 Plans:*** Demonstrate the first unmanned system certified on the U.S. Army table VI scout gunnery course and refinement of the Wingman operating system. ***FY 2019 Plans:*** Conduct final Military Utility Assessment (MUA) of maneuver operations and Wingman technologies in cooperation with U.S. Central Command and U.S. Army. Transition components to Product Manager, U.S. Army Applique and Large Unmanned Ground Systems (PM USA ALUGS); Program Executive Officer, U.S. Marine Corps Land Systems; and U.S. Army Research, Development, Engineering Command. Complete the JCTD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** No change in funding profile.	2.000	3.000	3.000
Title: Scanning Infra-Red (IR) Sensor for Unmanned Aerial Vehicle (UAV) Detection and Tracking (SISUDT)	1.500	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Previously funded as an enabling technology within the JCTD program. SISUDT responds to a Joint Urgent Operational Need request to detect, track, identify and evaluate threats by unmanned aerial systems (UAS) at forward operating bases (FOB). Partners involved in SISUDT include U.S. Central Command, U.S. Navy, and Massachusetts Institute of Technology Lincoln Labs (MIT-LL). The SISUDT Counter-Unmanned Aerial System (C-UAS) is managed by the U.S. Central Command's Technology Tiger Team to develop a multi-sensor C-UAS to detect, track, and identify UAS in the vicinity of a forward operating base (FOB). Conducted a six month assessment at a FOB in the U.S. Central Command area of responsibility. At the end of the assessment, SISUDT transitioned to U.S. Forces Afghanistan for continued operations.			
Accomplishments/Planned Programs Subtotals	127.961	105.871	106.049

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Successful JCTDs can transition to acquisition via one of several methods:
- The JCTD addresses a documented capability gap in an existing program of record (PoR). The existing PoR can acquire, further develop, sustain, and provide the capability under existing program documentation.
- The capabilities address capability gaps that naturally fit with an existing PoR, but program documentation addressing the new capabilities does not exist. In these cases, existing PoR documentation (such as the Capabilities Development Document or Capabilities Production Document) is revised to include the new capabilities from the JCTD, and the JCTD capabilities transition to the PoR.
- The capabilities address a current operational need without requiring PoR changes. In these cases, the JCTD capabilities may transition directly to operational use, with sustainment (operations and maintenance) funding arranged through the gaining command.
- The capabilities may be widely applicable commodity products, useful to many commands. In these cases, the commodity products listed on General Services Administration schedule, and made available for purchase by any commands needing the capability, using procurement funds.
- Results of JCTD can be used to inform the research and engineering, acquisition, or requirements process.

E. Performance Metrics

Strategic Goals Supported:
- Develop and demonstrate a prototype that fills a joint capability gap.
- Demonstrate a capability to address a DoD key strategic gap.
- Develop a prototype that informs the acquisition and requirements process.
- Independent Assessment Capability.

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603648D8Z / *Joint Capability Technology Demonstration (JCTD)*	**Project (Number/Name)** 648 / *Joint Capability Technology Demonstration (JCTD)*

- Successful military utility assessment (MUA).

MEASURABLE OUTCOMES:
• JCTDs will demonstrate capability objectives within 24-48 months:
• The JCTD program will continue to achieve high transition rates. In FY 2017, 50 percent of completed JCTDs successfully transitioned and exceeded the DoD Strategic Performance goal of 40 percent. Two of six completed JCTDs transitioned to a new or existing Program(s) of Record. One transitioned to fieldable-prototypes (residual capabilities) sustained by non-JCTD funds in direct support of operations in theater. Three were returned to the technology base for further analysis and/or future use.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*

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	-	9.123	12.661	12.696	-	12.696	2.866	2.920	2.973	3.027	Continuing	Continuing
663: *Network Communications Analysis*	-	9.123	12.661	12.696	-	12.696	2.866	2.920	2.973	3.027	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

Currently fielded satellite communications (SATCOM), terrestrial, and Tactical Data Links (TDLs) will be adversely affected during operations in contested Anti-Access/Area-Denial (A2/AD) environments. The primary threat is from sophisticated electronic warfare capable of advanced jamming and signal collection techniques that are rapidly evolving to be more capable and agile. Department of Defense (DoD) advances in smart sensors and smart weapons have an urgent need for more resilient networks than tactical data links of today. In FY 2016, the Network Communications Capability Program (NCCP) returned with a new focus on developing enabling technologies for Joint assured communications networks. The goals of this program are: to mitigate degradation across battlespace tiers and domains and to provide agility that will support the mission needs of Joint Functional Component Commanders, Joint Force Commanders, and deployed forces.

The DoD's current TDLs platforms and capabilities are not sufficiently protected from emerging adversary threats and contain insufficient capacity for future needs. In order to enable the promise of net-centric operations for the warfighter, the next generation of airborne, surface, and ground tactical networks must provide greater affordability, higher network capacity, greater durability against electronic attack, better network connectivity, and faster response times to the changing demands from airborne, maritime, and ground users. Many line-of-sight (LOS), beyond LOS, and SATCOM waveforms have been integrated onto platforms for various missions. These waveforms necessarily exhibit tradeoffs in target performance attributes including capacity, latency, protection, and complexity. As a result, no single waveform capability will be able to satisfy all emerging mission needs emphasizing the need for interoperability and software defined waveforms. The challenge is to understand the essential needs of the users, avoid needless redundancy, develop affordable capabilities, and integrate separate capabilities into a cohesive network. This research will develop transformative technologies to ensure performance in contested A2/AD environments by focusing on future communications networks that are a "leap ahead" of today's capabilities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	9.331	12.661	7.779	-	7.779
Current President's Budget	9.123	12.661	12.696	-	12.696
Total Adjustments	-0.208	0.000	4.917	-	4.917
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.197	-			
• FFRDC Transfer	-0.010	-	-	-	-
• Other Program Adjustments	-0.001	-	5.002	-	5.002
• Economic Assumption	-	-	-0.085	-	-0.085

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*	**Project (Number/Name)** 663 / *Network Communications Analysis*

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
663: *Network Communications Analysis*	-	9.123	12.661	12.696	-	12.696	2.866	2.920	2.973	3.027	Continuing	Continuing

A. Mission Description and Budget Item Justification

In a contested environment, especially when conducting forward operations, platforms face a significant electronic warfare threat. The primary threat is from advanced jamming, signal collection, and geolocation techniques that are rapidly evolving to be more capable and agile. DoD advances in smart sensors and weapons demand robust tactical waveforms and networks with greater capacity but lower cost than communication links of today.

The Future Autonomous Battlespace RF with Integrated Communications (FABRIC) (formerly referred to as Robust Tactical Data Links Modernization (RTDLM)) program will develop next generation communications layer architecture for tactical networks for operations in anti-access/area denial (A2/AD) threat environments. This architecture will deliver capacity and affordability to enable future smart sensors and smart weapons. The network architecture will be flexible enough to support Commander's Intent in any mission, environment, operating tactical platform, and weapon system under various threat conditions. FABRIC's efforts will focus on developing the advanced component technologies, such as Anti-Jam(AJ), Low Probability of Interference (LPI), Low Probability of Detection (LPD), and Low Probability of Exploitation (LPE) waveforms; adaptive processing algorithms; adaptive antenna technologies (transmit/receive/nulling); adaptive power control; Dynamic Spectrum Access (DSA)/Dynamic Spectrum Management (DSM) techniques; self-healing mechanisms and cyber hardening; and advanced routing to ensure Quality of Service. The guiding tenets for creating this new Command, Control, Communications, Computers, & Intelligence (C4I) capability encompass enabling new missions, i.e. providing resilient tactical data links, communications and networking "service level" capabilities, interoperation, cost (affordable), and improved performance in terms of military value.

Based on the developed thresholds and objectives for the required network architecture, the specific advanced component technologies were prioritized and form the foundation of the FABRIC design. Through simulation and field experimentation, FABRIC will verify the technology in operationally relevant environments against representative threats, and facilitate the migration and transition of these technologies to service platforms, radios, and other combat mission systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Future Autonomous Battlespace RF with Integrated Communications (FABRIC) ***Description:*** The FABRIC program develops hardware, software, and algorithms to advance network technologies creating a robust tactical network to operate in contested A2/AD environments. The project will investigate and develop flexible, high performance, and affordable technologies for the tactical network, supporting capability changes as a mission progresses from phase to phase. The project will develop and mature technologies to support direct transition of the algorithms, prototype implementations, waveform improvements, and system design improvements to radio, waveform, and weapon systems programs managed by each military department. ***FY 2018 Plans:***	9.123	12.661	12.696

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*	**Project (Number/Name)** 663 / *Network Communications Analysis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
System Integration - Define the overall system architecture. - Determine integration benchmarks; design and execute integration tests. - Conduct modeling and simulation of aperture and platform interactions. Transition Planning - Identify and consolidate transition paths including performance requirements and constraints. - Continue to modify and mature variations of the A2/AD related scenarios to identify performance parameters and potential transition opportunities. - Define and execute scenarios in a mega-city environment and those that involve Electronic Warfare (EW), signals intelligence (SIGINT), RADAR or Precision/Navigation/Timing (PNT) functions interacting with FABRIC to include red electromagnetic interactions. Modeling and Simulation - Leverage and integrate into the ns-3 network simulator, the Joint Semi-Automated Forces high level architecture framework, to allow utilization of the “Mega-city/Jakarta” model. - Extend network protocols and modem performance into ns-3. Aperture Development - Design program baseline aperture(s) that provide directional 360° coverage by mid FY 2018. - Develop thermal and electrical model of intended electronically steerable antennas with no power amplifiers. - Conduct a study focusing on the low-cost manufacturing of an electronically scanned array (ESA). Prototyping and experimentation - Code and refine FABRIC directional networking functionality to enable measurements of performance in realistic mission environments. - Lab-bench prototyping of the directional networking functionality (radio frequency (RF)) front-end and the ESA. Hardware and Software Development - Complete detailed design of chip processor and fabricate through 14 nanometer trusted foundry. - Continue software and firmware development (development, optimization, verification & validation) to include completion of software modeling on the instruction set simulator. - Create emulation framework in Defense Advanced Research Projects Agency's (DARPA) Arrays at Commercial Timescales (ACT) common module.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*	**Project (Number/Name)** 663 / *Network Communications Analysis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Develop FABRIC software architecture. Directional Networking Functionality - Code and refine FABRIC directional networking functionality to enable measurements of performance in realistic mission environments. - Conduct performance and scalability analysis to inform upgrade recommendations. - Baseline upgrades (waveform, networking concepts, antenna management). - Complete ns-3 integration of channel, beamforming, modem, and other directional networking functionalities. - Complete modeling of system level controls, interfaces, and DARPA ACT modules. ***FY 2019 Plans:*** System Integration - Complete integration of the DARPA ACT chips with the chip processor emulation board. - Complete integration of major functional system elements and hardware/software components (such as ESA, RF, and processing). - Construct and exercise preliminary FABRIC network for system integration and validation. Scenarios and Transition Planning - Complete implementation of the mega city scenario. - Continue to refine joint demonstration plans. - Modify and mature variations of the A2/AD related scenarios to match realistic performance parameters to align with Service transition partners. - Explore dynamic mission adjustments and communication interactions with realistic EW/SIGINT/RADAR/PNT functions on various platforms. Prototyping, Lab, and Field Testing - Complete physical, low cost (with size, weight, and power considerations) phased array prototype. - Design and execute lab and controlled field testing of beam forming capability at the Air Force Research Laboratory's Stockbridge Controlled Contested Environment site. - Evaluate performance results during field testing against planned performance parameters and adjust accordingly. - Plan for a system field testing of the network supporting links to unmanned aerial vehicle platforms and nearby units operating in an urban/dense environment. - Identify deficiencies in hardware.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*	**Project (Number/Name)** 663 / *Network Communications Analysis*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Hardware/Software - Probe test processor chips for functionality. - Deliver processor chip design for fabrication (second run on trusted foundry). - Complete and maintain suite of software development tools such as libraries, compiler, assembler, linker, profiler, debugger, mission developer, executable code, and loader. - Deliver full baseline software stack; validate execution speed, latency, and operational resilience of software. - Code and port EW/SIGINT/RADAR/PNT functions into software architecture. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 adjustments are reflective of higher priority DoD requirements.			
Accomplishments/Planned Programs Subtotals	9.123	12.661	12.696

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

The FABRIC project will address capability gaps for Joint tactical data link networks by developing the technologies that the Military can incorporate in future platform and radio acquisitions. The proposed experimentation, with field demonstrations and modeling, will increase the Technology Readiness Level (TRL) of critical technology components, suitable for transition to acquisition programs. This will also provide DoD leadership with the supporting technical and cost details to identify candidate "building blocks" for timely incremental improvements.

E. Performance Metrics

The Research, Development, Test, and Evaluation (RDT&E) goal for FABRIC is capability improvements that achieve greater than 70 percent “Buy-Back” of the tactical data link operational range and 80 percent of the area of operation lost in the A2/AD environment.

- Enhanced Link Capacity: 10X-100X Faster
- Enhanced Connectivity: 4X-10X Network Neighbor Connections
- Enhanced Spatial/Time Filtering: 4-7 Adaptive Nulls (Scenario Dependent)
- Receiver Based Mitigation: 20-30dB per Jammer Type (Scenario Dependent)
- Enhanced LPI/LPD: 4X-10X Closer Range to Target with Same Percent LPI/LPD
- Enhanced Network Scalability: 300-1000 nodes
- Low cost AESA systems: <$25K each

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*	**Project (Number/Name)** 663 / *Network Communications Analysis*

Achieve significant DoD savings for radio modifications or integration into new terminals or platforms (economies of scale) as services share non-recurring development costs for common and successful TDL enhancements.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*

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	398.688	177.419	136.159	114.637	0.000	114.637	87.647	68.752	69.925	71.207	Continuing	Continuing
680: *Manufacturing Science and Technology Program*	149.403	25.527	21.512	22.328	0.000	22.328	30.162	34.602	34.583	34.539	Continuing	Continuing
350: *Manufacturing Innovation Institutes*	249.285	126.892	114.647	92.309	0.000	92.309	57.485	34.150	35.342	36.668	Continuing	Continuing
607: *National Security Technology Accelerator Program*	0.000	25.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Defense-wide Manufacturing Science and Technology (DMS&T) program is the joint, defense-wide component of the DoD Manufacturing Technology (ManTech) Program directed in Title 10 U.S.C. Section 2521, the latter of which represents the Department's comprehensive advanced manufacturing program focused on enabling the strategic goals of timely, affordable delivery of dominant technologies to the warfighter, and improving the acquisition and sustainment of defense products and systems across their life cycles. Designing for manufacturability early in the development of defense-essential products and systems can yield dramatic and positive impacts for the Department's operational and modernization missions.

The DMS&T component of the DoD ManTech program specifically focuses on the development of cross-cutting and potentially game-changing manufacturing technologies, processes and capabilities that are typically beyond the scope or risk of any one Military Department or Defense Agency or platform.These high-leverage, defense-wide investments are designed to benefit the performance, affordability, and delivery timelines/deployment cycles of many of the department's most essential products and systems in ways that are not typically achievable through the efforts of a single service, agency or program office.

The DMS&T program, therefore, is a unique and fundamental DoD ManTech Program component that is needed to optimize a coordinated manufacturing technology development process across the department broadly. Concurrent development of manufacturing processes and capabilities along with S&T development enables the timely, affordable adoption and deployment of emerging technologies needed to maintain U.S. warfighting dominance. Key DMS&T technical areas for investment include Advanced Electronics and Optics Manufacturing, Advanced Materials Manufacturing, Enterprise and Emerging Manufacturing, and respective technology focus areas addressed by each of the DoD-led manufacturing innovation institutes (discussed in the next paragraph). Advanced Electronics and Optics addresses advanced manufacturing technologies for a wide range of applications such as sensors, radars, power generation, switches, and optics for defense applications. Advanced Materials addresses advanced manufacturing technologies for a wide range of materials such as composites, metals, ceramics, nanomaterials, metamaterials, and low observables. Enterprise and Emerging Manufacturing addresses advanced manufacturing technologies and enterprise business practices for defense applications. Key focus areas include the industrial information infrastructure, advanced design/qualification/cost tools, supply network integration technologies and management practices, direct digital (or additive) manufacturing, machining; robotics, assembly, and joining.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*

Manufacturing innovation institutes established by the DoD and part of the whole-of-government Manufacturing USA Program are also funded in this program element. Technical innovation and leadership in U.S. manufacturing are essential to sustaining the foundations of industrial competitiveness to enable our military to maintain technological advantage and global dominance. Eight DoD Manufacturing USA institutes have been established to serve as regional hubs accelerating technological innovation and associated production processes and educational/workforce competencies for military and commercial applications via shared public-private sectors. These Manufacturing USA institutes, supported by resources from multiple U.S. Government agencies, are generating significant industry cost-share for manufacturing innovation and are forming new technology transition pathways via regional hubs spurring active collaboration among government, industry, and academia to help meet critical government and warfighter needs. The overall concept of the Manufacturing USA program (previously named the National Network for Manufacturing Innovation until changed in FY16) and the design of its manufacturing innovation institutes are provided in several key federal documents; among them: 1) the President's National Science and Technology Council (NSTC) report by the Advanced Manufacturing National Program Office entitled, "National Network for Manufacturing Innovation: A Preliminary Design," published in January 2013, and more recently, in the following two NSTC reports: 2) "National Network for Manufacturing Innovation Program Strategic Plan" and 3) "National Network for Manufacturing Innovation Annual Report," both published in February 2016.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	158.398	136.159	115.573	-	115.573
Current President's Budget	177.419	136.159	114.637	-	114.637
Total Adjustments	19.021	0.000	-0.936	-	-0.936
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	25.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-5.805	-			
• SBIR/STTR Transfer	-	-			
• FFRDC Transfer	-0.174	-	-	-	-
• Economic Adjustment	-	-	-0.936	-	-0.936

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2017**	**FY 2018**
Project: 607: *National Security Technology Accelerator Program*		
Congressional Add: *National Security Technology Accelerator*	25.000	0.000
Congressional Add Subtotals for Project: 607	25.000	0.000
Congressional Add Totals for all Projects	25.000	0.000

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* **/** BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680D8Z **/** *Defense Wide Manufacturing Science and Technology Program*

Change Summary Explanation

Three project codes are used in this Program Element (PE) to distinguish between DMS&T Manufacturing Technology investments (P680), the manufacturing innovation institute investments (P350), and the newly added program the National Security Technology Accelerator (P607). The growth in funding in this PE from prior President's budgets is primarily associated with the additional of the National Security Technology Accelerator program.

Economic Adjustment for inflation.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 680 / *Manufacturing Science and Technology Program*

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
680: *Manufacturing Science and Technology Program*	149.403	25.527	21.512	22.328	0.000	22.328	30.162	34.602	34.583	34.539	Continuing	Continuing

A. Mission Description and Budget Item Justification

The DMS&T investment strategy follows a two-pronged approach built on: 1) broad technology initiatives and 2) specific individual projects meeting more focused manufacturing technology needs. Investments in both cases are built and managed in collaboration with the Department's research, development and acquisition (RDA) communities (including active, ongoing coordination with the DoD ManTech Program's Joint Defense Manufacturing Technology Panel) and industry and target the development of defense-essential advanced manufacturing processes and associated workforce capabilities. The portfolio includes a focus on above-the-shop-floor new manufacturing processes and practices having the potential to improve manufacturing efficiencies at broader, enterprise levels. Single specific projects address investment opportunities not associated with selected technology initiatives and enable the program to more surgically apply investments to compelling and sometimes urgent manufacturing needs.

Data calls are launched through two methods to identify technology initiatives and single specific issues requiring investment. One method is through the JDMTP. The JDMTP is comprised of the ManTech Directors from the Services, Defense Logistics Agency, and Office of Secretary of Defense (OSD). The call is distributed through the ManTech Directors to the four JDMTP sub panels: Metals Processing and Fabrication Subpanel, Composites Processing and Fabrication Subpanel, Electronics Processing and Fabrication Subpanel, and Advanced Manufacturing Enterprise Subpanel. Potential candidates are evaluated by the JDMTP based on criteria set forth in the call and announcements, and then down-selected for further development prior to final selection. The other method is through funding opportunity announcements to industry. Priority is given to investments that support affordability and producibility of critical enabling manufacturing technologies that cut across multiple platforms. Investments also balance defense priorities in specialty materials, electronics, propulsion and power, and manufacturing processes including "above the shop floor" (lean and business technologies facilitating interoperable manufacturing). Final projects are selected by the OSD ManTech Director, considering input from the JDMTP,and as approved by Deputy Assistant Secretary of Defense, Manufacturing and Industrial Base Policy (MIBP). Technology initiatives and projects are executed at the Component level.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Advanced Electronics and Optics ***Description:*** Advanced Electronics and Optics is a series of efforts addressing advanced manufacturing technologies for a wide range of applications such as sensors, radars, power generation, switches, and optics for defense applications. Focal points are productivity and efficiency gains in the defense manufacturing base to accelerate delivery of technical capabilities to impact current warfighting operations, and manufacturing technologies to reduce the cost, acquisition time and risk of our major defense acquisition programs. Future	16.766	12.213	13.029	0.000	13.029

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

efforts will focus on advances in fuel cells, lasers, enhanced acuity microdisplays, and transparent ceramics for opto-mechanical and armor applications.

The Transparent Ceramic Initiative will address DoD applications for electro-optics, including fibers, films, and bulk solid state components, such as windows. Typical materials include: sapphire, ALON, and spinel. Transparent ceramics offer the potential for improved ballistic strength for battlefield armor and personnel protection. Investments include but are not limited to: high strength spinel scale-up, Nanocomposite Optical Ceramics (NCOC) powder scale-up, infrared windows, and curved transparent ceramics.

Projects:

Mini Short-wave Infrared (SWIR) Cameras and Imagers (FY 2016): Expedite the transition of 10 um (TEC)-less SWIR cameras to the warfighter and develop wafer level processing techniques to improve yield and reduce contaminants in the SWIR focal plane array (FPA)/ camera assembly. Will establish the industrial base for SWIR technology systems and components. Reduced unit cost allows more individuals to carry imagers; 6x improved cost, reduced from $30K to $5K; 3x reduced size from 3cm3 to 1cm3; 3x reduced weight from 120 g to 40 g. Applications include COSI, INOD, COS3, AWST, Joint Effect Targeting System (JETS), IDNST, PAWS, and MTS-B.

Mini Vis - SWIR Cameras and Imagers (FY 2016): Develop a manufacturing capability to produce one camera that can see the entire spectral band of Visible, Near Infrared (NIR), and Short-wave Infrared (SWIR); while being compatible with visible, NIR, and SWIR laser pointers and illuminators. Applications include: COSI, INOD, COS3, Advanced Weapon Sight Technology (AWST), Joint Effect Targeting System (JETS), Integrated Day/ Night Sight Technology (IDNST), PAWS, and Multispectral Targeting System (MTS-B).

Manufacturability of Vertical Cavity Surface Emitting Lasers (VCSELs) – Phase II (FY 2016-2018): Develop the capability to produce a Multi-Function Laser Illuminator and Pointer that delivers the functionality of five different devices (Green, NIR, and Short-wave Infrared (SWIR) Laser Pointers plus NIR and SWIR illuminators) in a single, high-power, lightweight unit, which would give the warfighter commonality with all other weapon systems and be covert. Would provide the SWIR VCSEL a three-fold increase in efficiency and output power to meet critical needs for covert illumination in both High Definition and SXGA formats. Applications include: PUMA, RAVEN, TigerShark, Anubis, Spectre-FINDER, Speckles, TigerMoth, WAAS, PAWS, IPODS, AngelFire, MAV-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
OBAT, nLoss, LOS-short, CLRF, Joint Effect Targeting System (JETS), IDNST, TLDS, Big Safari, OEF, OIF, STINGER , and ARGUS, others. Vital Infrared Sensor Technology Acceleration (VISTA) High Temp Mid-Wave Infrared (MWIR) Detectors (FY 2016-2017): Establish a critical domestic industrial base for MWIR focal plan arrays (FPA) having capabilities in III-V antimony-based Infrared (IR) FPAs to reduce size, weight, power, and cost while increasing yield and operability as an alternative to current technology. Will achieve wafer production scale-up to 40-50 wafers per month while shortening sensor turn-on and cool down time by 50%, extending cooler lifetimes 150% - 200% as a result of reduced stress during temperature cycling, and substantially reducing the sensor lifecycle maintenance cost. Applications include: Air Force: EODAS Enhancement (F-35), EOTS Enhancement (F-35), LWIRST (F-15), Targeting System Enhancements (MQ-9, F-16), Overhead Persistent Infrared (OPIR); Army: Next Gen FLIR, Degraded Visual Environment, Rotary Wing Pilotage; Navy: Shipboard Multifunction Sensors (APDIS), Overhead Persistent Surveillance for USMC, UAV, and Navy: BAMS, F-18 (Advanced IRST), EO/IR Standard Integration System (EISIS), and Affordable Modular Panoramic Photonics Mast. Improved Focal Plane Array (FPA) – Hyperspectral – Phase II (FY 2016): Demonstrate utility of III-V based FPAs for Long-Wave Infrared (LWIR) Hyperspectral (HIS) applications. Up to $1M/year/sensor reduction in system life cycle costs compared to arsenic-doped silicon blocked impurity band (Si:As BIB) detectors. Significant reduction in up-front costs compared to Mercury Cadmium Telluride (MCT). Improved reliability, maintainability, and availability, along with increased detection range. Organic Light Emitting Diode (OLED) Microdisplays - Phase II (FY 2016-2017): Establish manufacturing capability for producing an ultra-high resolution, high brightness, high contrast, full color microdisplay at a low unit cost. Mature and combine manufacturing processes: Silicon on Insulator (SOI) and Direct Patterning technologies to enable a 5X improvement in yield and 5X longer lifetime of displays, reducing life cycle costs. $221.7M savings for aviation and Enhanced Visual Acuity (EVA) goggles (27,700 displays between 2017-2032) x $8K/unit savings). Applications include F-35 Heads-up Helmet Mounted Display System, Apache, EVA, F-18, F-15, F-16, affordable color/monochrome displays with high brightness and high contrast to enable Warfighter to fully use sensors and cuing/augmented reality hardware. Nanocomposite Optical Ceramics (NCOC)(FY 2017-2018): Advance manufacturing maturity of NCOC to replace sapphire. The large reduction of emissivity at elevated temperatures experienced during flight makes NCOC					

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Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 680 / *Manufacturing Science and Technology Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
more favorable for a missile dome by increasing the signal to noise ratio. Effort will focus on scale-up NCOC dome manufacturing processes to meet projected AIM-9X full rate production quantities. ***FY 2018 Plans:*** Manufacturability of Vertical-Cavity Surface Emitting Lasers – Phase II: continue device development and additional product transitions; obtain feedback from end users and implement improvements. Nanocomposite Optical Ceramics (NCOC): Continue powder conditioning, blank forming, heat treatment, optical finishing and coating related activities; measure results and assess Manufacturing Readiness Levels. ***FY 2019 Base Plans:*** Manufacturability of Vertical-Cavity Surface Emitting Lasers – Phase II: continue device development and additional product transitions; obtain feedback from end users and implement improvements. Nanocomposite Optical Ceramics (NCOC): Continue powder conditioning, blank forming, heat treatment, optical finishing and coating related activities; measure results and assess Manufacturing Readiness Levels. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase from 12.213 to 13.029 to support program priorities					
Title: Advanced Materials Manufacturing ***Description:*** Advanced Materials Manufacturing is a series of efforts addressing advanced manufacturing technologies for a wide range of materials such as composites, metals, ceramics, nanomaterials, and metamaterials. Through productivity and efficiency gains, these manufacturing technologies will accelerate delivery of technical capabilities to impact current warfighting operations, while reducing the cost, acquisition time and risk of our major defense acquisition programs. Advanced materials manufacturing technologies undergoing development include materials for ballistic survivability and ballistic protection, survivability and rapid fabrication of structural components. Advanced Propulsion Initiative: Advance propulsion has a crucial need to develop fuel efficient sustainable propulsion capabilities. Several technologies will be developed including Risk-based Life Cycle Management for	5.713	5.508	5.508	0.000	5.508

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
System Sustainment and As-Manufactured and As-Maintained State Awareness. In addition, technologies will be pursued addressing capability gaps associated with adaptive engine design and high performance lightweight materials, organic matrix composites, oxide/oxide composites, thermal barrier coatings for high temperature structure and light weight alloys. Additional capabilities will focus on unique manufacturing challenges associated with affordable Medium-Small Engine fabrication methods including Expendables. Projects: 40MM M433 Warhead Producibility (FY 2016): Achieve improved anti-personnel lethality at the squad level, increasing first shot effectiveness against personnel targets through optimization of production process prior to transition to Full Rate Production, avoiding high cartridge unit costs. Primary applications include Mk 19 GMG, M203 GL, M320GL, and M32 MSGL. Secondary applications include Cannon and Tank Calibers, and Hand Grenades. Cold Spray Repair and Rebuild Phase II Large Structures (FY 2016): Expand the Cold Spray product envelope from 5 feet to a target of 40 feet to enable large tubular component repair. Applications include Seawolf Class Submarine Periscopes and TD-63 Actuators. Dimensions on Day One (FY 2016): Demonstrate a methodology that accurately predicts and accounts for the numerous geometric, tooling and material factors impacting finished composite parts enabling the correct upfront process and tooling design to yield first article parts meeting the “dimensional requirements on day 1”. Applications include F-35/UCLASS/F/A-XX/Long Range Strike for maintaining part and aircraft tolerances, which enables survivable, supportable and affordable air vehicles. Large Scale Encapsulate Ceramics - Phase II (FY 2016): Enable combat vehicles to defeat the large caliber Kinetic and Chemical Energy objective threats within the allocated weight parameters. Help address affordability of the armor, with an estimated cost reduction of $10K /sq. foot. Armor panels will be producible in the shapes required by individual vehicles. Applications include Abrams, which has a known protection limitation. GCV and other vehicles will use this technology to design those areas of vehicles subject to large caliber KE and CE threats. Out of Autoclave Processing of Organic Matrix Composites (OMCs) for Advanced Propulsion (FY 2017-2018): Current state of the art out of autoclave processable OMCs are currently limited to a service life of between 325F and 375F limiting advanced propulsion applications. Expanding performance of OMCs to temperatures					

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
between 400F and 625F will dramatically increase the design trade space for developing the next generation advanced propulsion systems. Advanced propulsion structure includes front frames, vanes, stators and outer by-pass ducts. Insertion of this technology onto the AETP program will lower cost, increase range and maintain performance for the next generation tactical aircraft. Fabrication of Non-Eroding Metallic Throat (FY 2016-2018): Scale the manufacturing of Thin walled, Non-Eroding Tungsten (W) Throats from 4” up to 12” inner throat diameters. Applications include Stage 2 & Stage 3 ICBMs as well as Stage 2 Standard Missile III. Advanced Technology Capability (FY 2016-2018): Development of advanced technologies that support warfighter survivability and capability against advanced threats. Enables new capabilities to be produced in sufficient affordable quantities to allow transition to multiple platforms. Advanced Propulsion Initiative: Advance propulsion has a crucial need to develop fuel efficient sustainable propulsion capabilities. Several technologies will be developed including Risk-based Life Cycle Management for System Sustainment and As-Manufactured and As-Maintained State Awareness. In addition, technologies will be pursued addressing capability gaps associated with adaptive engine design and high performance lightweight materials, organic matrix composites, oxide/oxide composites, thermal barrier coatings for high temperature structure and light weight alloys. Additional capabilities will focus on unique manufacturing challenges associated with affordable Medium-Small Engine fabrication methods including Expendables. Projects: 40MM M433 Warhead Producibility (FY 2016): Achieve improved anti-personnel lethality at the squad level, increasing first shot effectiveness against personnel targets through optimization of production process prior to transition to Full Rate Production, avoiding high cartridge unit costs. Primary applications include Mk 19 GMG, M203 GL, M320GL, and M32 MSGL. Secondary applications include Cannon and Tank Calibers, and Hand Grenades. Cold Spray Repair and Rebuild Phase II Large Structures (FY 2016): Expand the Cold Spray product envelope from 5 feet to a target of 40 feet to enable large tubular component repair. Applications include Seawolf Class Submarine Periscopes and TD-63 Actuators.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Dimensions on Day One (FY 2016): Demonstrate a methodology that accurately predicts and accounts for the numerous geometric, tooling and material factors impacting finished composite parts enabling the correct upfront process and tooling design to yield first article parts meeting the "dimensional requirements on day 1". Applications include F-35/UCLASS/F/A-XX/Long Range Strike for maintaining part and aircraft tolerances, which enables survivable, supportable and affordable air vehicles. Large Scale Encapsulate Ceramics - Phase II (FY 2016): Enable combat vehicles to defeat the large caliber Kinetic and Chemical Energy objective threats within the allocated weight parameters. Help address affordability of the armor, with an estimated cost reduction of $10K /sq. foot. Armor panels will be producible in the shapes required by individual vehicles. Applications include Abrams, which has a known protection limitation. GCV and other vehicles will use this technology to design those areas of vehicles subject to large caliber KE and CE threats. Out of Autoclave Processing of Organic Matrix Composites (OMCs) for Advanced Propulsion (FY 2017-2018): Current state of the art out of autoclave processable OMCs are currently limited to a service life of between 325F and 375F limiting advanced propulsion applications. Expanding performance of OMCs to temperatures between 400F and 625F will dramatically increase the design trade space for developing the next generation advanced propulsion systems. Advanced propulsion structure includes front frames, vanes, stators and outer by-pass ducts. Insertion of this technology onto the AETP program will lower cost, increase range and maintain performance for the next generation tactical aircraft. Fabrication of Non-Eroding Metallic Throat (FY 2016-2018): Scale the manufacturing of Thin walled, Non-Eroding Tungsten (W) Throats from 4" up to 12" inner throat diameters. Applications include Stage 2 & Stage 3 ICBMs as well as Stage 2 Standard Missile III. Advanced Technology Capability (FY 2016-2018): Development of advanced technologies that support warfighter survivability and capability against advanced threats. Enables new capabilities to be produced in sufficient affordable quantities to allow transition to multiple platforms. ***FY 2018 Plans:*** Fabrication of Non-eroding Metallic Throat: Modify existing system with tooling and plasma gun for 12" diameter throats; fabricate tungsten base alloyed powders; continue to refine fabrication of 6" and 9" diameter throats;					

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
make 12” diameter material property specimens; conduct sintering and Hot Isostatic Processing; improve manufacturing methods and practices to reduce unit costs and reduce rejects; finalize the design of 6” and 9” diameter throats; conduct a preliminary design analysis for 12” diameter throats; test 12” material property specimens. Out of Autoclave Processing of Organic Matrix Composites (OMCs) for Advanced Propulsion: Assess required operating parameters for processing Organic Matrix Composites without autoclaves. Advanced Technology Capability: Improvement and continued development of new and novel advanced manufacturing processes to enable scale up of production capabilities. ***FY 2019 Base Plans:*** Fabrication of Non-eroding Metallic Throat: Modify existing system with tooling and plasma gun for 12” diameter throats; fabricate tungsten base alloyed powders; continue to refine fabrication of 6” and 9” diameter throats; make 12” diameter material property specimens; conduct sintering and Hot Isostatic Processing; improve manufacturing methods and practices to reduce unit costs and reduce rejects; finalize the design of 6” and 9” diameter throats; conduct a preliminary design analysis for 12” diameter throats; test 12” material property specimens. Out of Autoclave Processing of Organic Matrix Composites (OMCs) for Advanced Propulsion: Assess required operating parameters for processing Organic Matrix Composites without autoclaves. Advanced Technology Capability: Improvement and continued development of new and novel advanced manufacturing processes to enable scale up of production capabilities. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Enterprise and Emerging Manufacturing ***Description:*** Enterprise and Emerging Manufacturing addresses advanced manufacturing technologies and business practices for defense applications. Key focus areas include direct digital (or additive) manufacturing,	3.048	3.791	3.791	0.000	3.791

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

advanced manufacturing enterprise, machining, robotics, assembly, and joining. Projects selected will accelerate delivery of technical capabilities to impact current warfighting operations while reducing cost, acquisition time, and risk of major defense acquisition programs.

It is paramount for the U.S. military to improve its own agility and flexibility. The focus is to find a solution to overcome a burdensome acquisition cycle requiring a great amount of cost, time, security, and storage space. Through the use of secure satellite data links or a local parts database, warfighters can access computer-aided design (CAD) for replacement parts, allowing them to repair equipment without the need to establish supply chains or wait for shipments. It allows operators to modify a part's design based on its performance in the field.

Emerging manufacturing technologies undergoing development include: a large-scale challenge for advanced, interoperable machine tool applications, and methods for exchange of 3D official technical data throughout the supply chain and between the Government and contractors.

Projects:
MTConnect Challenge Phase II (FY 2016): Promote academia’s educational development and implementation of production interactive solutions to the broad U.S industrial base with the expansion of MTConnect Challenge that contributes to reduced cycle times and the development of real-time production metrics for adaptable dashboard applications.

Securing American Manufacturing (SAM) (FY 2016): develop a Trusted and Assured supply chain, identify threat vulnerabilities of industrial control systems, provide input to DoD policies, and shape follow-on investment to mitigate threat vulnerabilities. Applications span the US Defense Industrial Base.
Cyber Security for the Shop Floor - Phase II (FY 2017-2018): The manufacturing factory floor is a growing area of concern for DoD cyber security because defense contractors throughout the DoD's supply chain are continually targeted by cyber criminals seeking to: 1) steal technical data, including critical national security information and valuable commercial intellectual property; 2) alter data, thereby affecting processes and products; and 3) impair or deny process control, thereby damaging or shutting down operations. Protecting the operational systems of a manufacturing enterprise presents a different set of challenges from protecting enterprise IT systems and networks. This phase II project will develop a Trusted and Assured supply chain,

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
identify threat vulnerabilities of industrial control systems, provide input to DoD policies, and shape follow-on investment to mitigate threat vulnerabilities. Applications span the US Defense Industrial Base. ***FY 2018 Plans:*** Cybersecurity for the Shop Floor – Phase II: enhance the relationship with the trusted and assured supply chain, analyze and mitigate known and suspected threat vulnerabilities of industrial control systems, provide input to DoD policies, and document and study assessment results that discuss DFAR requirements and suppliers' mitigation and cost implications. ***FY 2019 Base Plans:*** Cybersecurity for the Shop Floor – Phase II: enhance the relationship with the trusted and assured supply chain, analyze and mitigate known and suspected threat vulnerabilities of industrial control systems, provide input to DoD policies, and document and study assessment ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Accomplishments/Planned Programs Subtotals	25.527	21.512	22.328	0.000	22.328

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• (BA3) 0603680F: *Air Force ManTech*	-	-	-	-	-	-	-	-	-		
• (BA3) 0603680N: *Navy ManTech*	-	-	-	-	-	-	-	-	-		
• (BA7) 0708045A: *Army ManTech - Industrial Preparedness*	-	-	-	-	-	-	-	-	-		
• (BA7) 0603680S: *DLA ManTech*	-	-	-	-	-	-	-	-	-		

Remarks

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D. Acquisition Strategy

Not applicable for this item. Outyear data for "Other Program Funding" is contained within the Service budgets.

E. Performance Metrics

The majority of DMS&T investment project performance metrics are specific to each effort and include measures identified in the project plans. Typical metrics include target dates and conditions-based milestones in project work breakdown schedules, production measures, production goals, production numbers and demonstration goals and dates.

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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
350: *Manufacturing Innovation Institutes*	249.285	126.892	114.647	92.309	0.000	92.309	57.485	34.150	35.342	36.668	Continuing	Continuing

A. Mission Description and Budget Item Justification

Technological innovation and leadership in manufacturing are essential to sustaining the foundations of economic competitiveness to maintain technological advantage and global dominance for our military. To support these goals, Manufacturing USA institutes, each led by non-profit 501(c) entities, have been established by the Department to serve as national assests with headquarters and regional hubs to accelerate technological innovation into commercial applications and concurrently develop the educational competencies and production processes via shared public-private sectors. Collaborative execution and funding by the Departments of Defense (DoD), Energy (DOE), and Commerce (DoC), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF) to support the establishment of these Manufacturing USA institutes will spur industry cost-share for manufacturing innovation and quickly develop a pathway for technology-focused regional hubs for collaboration among government, industry, and academia that will meet critical government and Warfighter needs. The overall concept of the Manufacturing USA program (previously named the National Network for Manufacturing Innovation until changed in FY16) and the design of its manufacturing innovation institutes are provided in several key federal documents; among them: 1) the President’s National Science and Technology Council (NSTC) report by the Advanced Manufacturing National Program Office entitled, “National Network for Manufacturing Innovation: A Preliminary Design,” published in January 2013, and more recently, in the following two NSTC reports: 2) ”National Network for Manufacturing Innovation Program Strategic Plan” and 3) “National Network for Manufacturing Innovation Annual Report,” both published in February 2016.

Each of the eight DoD-led Manufacturing USA institutes addressed in this budget is expected to be self-sustaining, without reliance on federal sustainment funding, by the end of the period defined by the respective cooperative agreement (CA) or technology investment agreement (TIA) between the federal government and the non-profit organization leading each institute consortium of members. This CA/TIA period is typically for five years, with the flexibility to extend the agreement up to two years for the benefit of DoD projects, technical achievement, etc., and to fully leverage the minimum 1:1 cost share.

Each of the eight DoD-led Manufacturing USA institutes is intended to:
1) Bring together industry, universities and community colleges, federal agencies, and state and local governments and organizations to create regionally-based but nationally-impactful public-private partnerships underpinning the formation of sustainable manufacturing innovation ecosystems
2) Accelerate innovation to bridge the gap between Research and Development (R&D) and deployment of technological innovations in domestic production of goods
3) Invest in industrially relevant manufacturing technologies with broad applications, accelerating innovation within DoD and across all manufacturing sectors to increase U.S. competitiveness
4) Provide shared assets to help companies access cutting-edge capabilities and equipment
5) Create an unparalleled environment to educate and train students and workers in advanced manufacturing skills
6) Focus on maturing the associated manufacturing technologies typically from from Manufacturing Readiness Level (MRL) 4 through 7

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

The first and second year of each of these new institutes is devoted to establishing a sustainable business model and operations, with continued refinement throughout the full period of the cooperative agreement, including: expanding the institute's membership base (as appropriate); establishing and solidifying revenue streams (e.g., funding from new R&D activity, membership fees, training and workforce development, certification and licensing, etc.); establishing provisional Executive Council and Technical Advisory committees to execute the business of each institute; finalizing Intellectual Property plans; developing technology roadmaps to inform investment strategies; opening industrial commons to provide for shared resource facilities available to all institute members; initiating workforce training programs in each technology area; establishing complementary relationships between Manufacturing USA institutes; analyzing the U.S. and Global industrial base in partnership with other government agencies to build upon the institute portfolio and address critical requirements; and further developing national technology roadmaps.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Institute 1 – National Additive Manufacturing Innovation Institute (America Makes)	0.000	1.026	2.000	0.000	2.000

Description: Additive manufacturing (i.e., "3D printing") is a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies such as traditional machining. Advanced additive manufacturing will benefit the DoD by enabling lifecycle cost savings and enhanced capabilities, including moving toward "focused logistics" – getting the right part in the right place in just the right time – for wartime and humanitarian missions using local supply chains. This Manufacturing USA institutes was established in 2012, with cooperative agreement funding included in this budget through FY 2015, and DoD program management costs included in subsequent fiscal years until all R&D projects, reporting, and fiduciary responsibilities are completed.

FY 2018 Plans:
Complete technical performance of all projects awarded in FY 2016 and make results available in the knowledge base. The period of performance for technical work under the Cooperative Agreement ends on August 31, 2017. Program management subsequently continues to provide oversight through August 31, 2019 for the close-out of all R&D projects, cost share accrual, final reporting, and transition to sustainability, in addition to completion of RDT&E fiduciary responsibilities.

FY 2019 Base Plans:
Complete technical performance of all projects awarded in FY 2016 and make results available in the knowledge base. The period of performance for technical work under the Cooperative Agreement ends on August 31, 2017. Program management subsequently continues to provide oversight through August 31, 2019 for the close-out of all R&D projects, cost share accrual, final reporting, and transition to sustainability, in addition to completion of RDT&E fiduciary responsibilities.

FY 2019 OCO Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 2 – Digital Manufacturing and Design Innovation Institute	12.000	4.635	1.750	0.000	1.750

Description: This national institute focus is on the implementation of the Digital Thread, the unencumbered flow of data across the lifecycle of a manufactured product encompassing data from design, production, supply, sourcing, inventory, assembly, quality, maintenance and sustainment. It includes the analysis of this data to reduce the time and cost of bringing new products to market, the elimination of barriers between design, manufacturing and sustainment by using both product data and process data in a way that is seamless and transparent.

Technology thrust areas: advanced manufacturing enterprise; intelligent machines; advanced analysis; open source platform; and cyber manufacturing system security.

This institute was established in February 2014, with cooperative agreement funding contribution included in this budget through FY 2018.

FY 2018 Plans:
Proposal calls are planned to occur approximately every six months, resulting in approximately 15 new projects with a planned value of $6 million. Conduct two Proposal Call Workshops, and award projects in the technology thrust areas identified above. Continue and expand the workforce development projects initiated in FY 2016 and 2017. Expand the Digital Manufacturing Commons Open Source collaboration tool. Revise the Technology Roadmap and Strategic Investment Plan to lead the technology domain in the completion of a Digital Thread. Announce the commercialization of new digital manufacturing and design technologies and industry capabilities. Significantly scale up commercialization, skill development and workforce development efforts from research projects and relationships with other government agencies.

FY 2019 Base Plans:
Proposal calls are planned to occur approximately every six months, resulting in approximately 15 new projects with a planned value of $6 million. Conduct two Proposal Call Workshops, and award projects in the technology thrust areas identified above. Continue and expand the workforce development projects initiated in FY 2016 and

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
2017. Expand the Digital Manufacturing Commons Open Source collaboration tool. Revise the Technology Roadmap and Strategic Investment Plan to lead the technology domain in the completion of a Digital Thread. Announce the commercialization of new digital manufacturing and design technologies and industry capabilities. Significantly scale up commercialization, skill development and workforce development efforts from research projects and relationships with other government agencies. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 3 – Lightweight and Modern Metals Manufacturing Innovation Institute (Lightweight Innovations for Tomorrow (LIFT)) ***Description:*** Advanced lightweight metals retain properties comparable to heavier, traditional materials, and can enable weight reduction in a variety of components and products with significant energy savings and increased payloads. This institute will scale-up research across multiple areas to accelerate market expansion by applying an integrated materials and manufacturing approach, addressing a lack of design guides and certifications as well as cost and scale-up challenges. The goal is to catalyze the development of an advanced lightweight metal U.S. supplier base and to enable DoD to realize greater speed and agility of manned, unmanned, and Warfighter systems as well as benefits for commercial applications. Technology thrust areas: (1) priority metal classes and its alloys of advanced high-strength steels, titanium, aluminum and magnesium; (2) technology development needs grouped into six pillars: melt processing; powder processing; thermo-mechanical processing; low cost - agile tooling, coatings, and joining and assembly; (3) Crosscutting themes: Integrated Computational Materials Engineering (ICME), design, life-cycle analysis, validation/certification, cost modeling, supply chain, corrosion, and ballistic/blast This institute was established in February 2014, with cooperative agreement funds programmed in this budget through FY 2018. ***FY 2018 Plans:***	12.000	4.108	4.500	0.000	4.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Project calls are planned to occur every six months, with a planned value of approximately $15 million for the year. Will conduct additional technology demonstrations and workshops to disseminate and implement the manufacturing technologies developed during previous project calls. Conduct a series of workshops targeting small and medium enterprises (SME) across the nation. Complete installation of all equipment planned for the HQ high bay area. Continue to invest in education and workforce development solutions that link education, workforce development, and economic development resources to help create a coordinated economic development asset. Continue implementation and expansion of the “work and learn” initiative developed in FY 2017. ***FY 2019 Base Plans:*** Project calls are planned to occur every six months, with a planned value of approximately $15 million for the year. Will conduct additional technology demonstrations and workshops to disseminate and implement the manufacturing technologies developed during previous project calls. Conduct a series of workshops targeting small and medium enterprises (SME) across the nation. Complete installation of all equipment planned for the HQ high bay area. Continue to invest in education and workforce development solutions that link education, workforce development, and economic development resources to help create a coordinated economic development asset. Continue implementation and expansion of the “work and learn” initiative developed in FY 2017. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 4 - Integrated Photonics Manufacturing Innovation Institute (American Institute for Manufacturing (AIM) Integrated Photonics) ***Description:*** Integrated photonics manufacturing advances the promise of unprecedented interconnection between electronics and photonics that will deliver previously unattainable performance in speed, density and power consumption, quickly providing differentiating benefits for defense applications such as high-speed signal processing, electronic warfare, information transport and computation, sensing, imaging and targeting. This institute will establish an end-to-end ‘ecosystem’ in the U.S. for advancing domestic integrated photonics manufacturing. This institute will include responsive integrated photonics fabrication foundry access, photonics-electronics integrated design tools, and advances in packaging, assembly and test automation. The goal will be	25.459	25.331	23.000	0.000	23.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
to catalyze a vibrant, enduring integrated photonics domestic industrial base, much as SEMATECH did with the domestic semiconductor industry. This institute was established in 2015, with cooperative agreement funding programmed in this budget through FY 2019. ***FY 2018 Plans:*** Continue advancement of the integrated photonics manufacturing innovation ecosystem, including release of mature photonic integrated circuit design tools for both silicon and indium phosphide-based photonics, full implementation of robust, high-yield multi-project wafer capabilities, and completed buildout of state-of-the-art package, assembly, and test tools and facilities in Rochester, NY. Conduct additional round of applied R&D project calls and award projects in the key core areas identified in the roadmapping phase. Transition FY 2017 projects' output to the supply chain. Leverage the now mature integrated photonics domestic ecosystem to develop novel integrated photonics components for DoD programs . Incorporate emerging domestic world-class integrated photonics work force into ecosystem. Begin to see a sustainable integrated photonics institute emerging, as evidenced by fee-for-service wafer production, increased membership, licensing of institute intellectual property, and other revenues being realized. This will help extend this institute beyond the length of the Cooperative Agreement, providing key manufacturing capability for the DoD requirements through 2020 and beyond. ***FY 2019 Base Plans:*** Continue advancement of the integrated photonics manufacturing innovation ecosystem, including release of mature photonic integrated circuit design tools for both silicon and indium phosphide-based photonics, full implementation of robust, high-yield multi-project wafer capabilities, and completed buildout of state-of-the-art package, assembly, and test tools and facilities in Rochester, NY. Conduct additional round of applied R&D project calls and award projects in the key core areas identified in the roadmapping phase. Transition FY 2017 projects' output to the supply chain. Leverage the now mature integrated photonics domestic ecosystem to develop novel integrated photonics components for DoD programs . Incorporate emerging domestic world-class integrated photonics work force into ecosystem. Begin to see a sustainable integrated photonics institute emerging, as evidenced by fee-for-service wafer production, increased membership, licensing of institute intellectual property, and other revenues being realized. This will help extend this institute beyond the length of					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
the Cooperative Agreement, providing key manufacturing capability for the DoD requirements through 2020 and beyond. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 5 – Flexible Hybrid Electronics Manufacturing Innovation Institute (Nextflex – America's Flexible Hybrid Electronics Manufacturing Institute) ***Description:*** Flexible hybrid electronics manufacturing involves highly tailorable devices on non-traditional, compliant substrates that combine thinned components manufactured from traditional processes with components that are added via "printing" processes. This institute will invest in prototyping and scale-up of manufacturing processes for high speed pick-and-place, printed circuits, and hybrid fabrication that will enable defense and commercial applications in wearable electronics, unattended sensors and integrated array antennas, medical devices and soft robotics devices, and the continuous improvement in SWAPC (Size, Weight And Power plus Cost) for electronic systems. This institute will establish an end-to-end domestic innovation 'ecosystem,' containing design, packaging, assembly and test automation research and workforce development capabilities which can be accessed by small, medium and large companies as well as academic institutes. The goal is to help enable the creation of a sustainable domestic industrial base which can rapidly respond to global needs using a quick technology cycle and scale-up. This institute was established in 2015, with cooperative agreement funds programmed in this budget through FY 2019. ***FY 2018 Plans:*** Project calls are expected to be made every year, with potential for continued Phase II investment for successful Projects from PC 1.0 and 2.0. Open a functioning pilot line for prototyping, using all major EMS processing steps for FHE. Focus on dissemination of the five Manufacturing Technology Area (MTA) and Technology Development Platform (TDP) results into Industry application areas. Refine workforce development activities to ensure sufficient pipeline expertise and recruitment. ***FY 2019 Base Plans:*** Project calls are expected to be made every year, with potential for continued Phase II investment for successful Projects from PC 1.0 and 2.0. Open a functioning pilot line for prototyping, using all major EMS processing	15.825	16.318	6.500	0.000	6.500

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
steps for FHE. Focus on dissemination of the five Manufacturing Technology Area (MTA) and Technology Development Platform (TDP) results into Industry application areas. Refine workforce development activities to ensure sufficient pipeline expertise and recruitment. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 6 - Revolutionary Fibers and Textiles Manufacturing Innovation Institute ***Description:*** The RFT institute will address the spectrum of manufacturing challenges associated with revolutionary fibers and textiles, from design to end products. It will support an end-to-end innovation 'ecosystem' in the U.S. for revolutionary fibers and textiles manufacturing and leverage domestic manufacturing facilities to develop and scale-up manufacturing processes. The institute will provide innovative system demonstrations based on robust design and simulation tools, pilot production facilities, a roster of subject matter experts, suppliers, and workforce development opportunities through targeted training and curriculum programs. This institute will be established in early 2016, with cooperative agreement funds programmed in this budget through FY 2020. ***FY 2018 Plans:*** The RFT institute will address the spectrum of manufacturing challenges associated with revolutionary fibers and textiles, from design to end products. It will support an end-to-end innovation 'ecosystem' in the U.S. for revolutionary fibers and textiles manufacturing and leverage domestic manufacturing facilities to develop and scale-up manufacturing processes. The institute will provide innovative system demonstrations based on robust design and simulation tools, pilot production facilities, a roster of subject matter experts, suppliers, and workforce development opportunities through targeted training and curriculum programs. This institute will be established in early 2016, with cooperative agreement funds programmed in this budget through FY 2020. ***FY 2019 Base Plans:*** The RFT institute will address the spectrum of manufacturing challenges associated with revolutionary fibers and textiles, from design to end products. It will support an end-to-end innovation 'ecosystem' in the U.S. for revolutionary fibers and textiles manufacturing and leverage domestic manufacturing facilities to develop and scale-up manufacturing processes. The institute will provide innovative system demonstrations based on robust	21.608	23.229	16.000	0.000	16.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
design and simulation tools, pilot production facilities, a roster of subject matter experts, suppliers, and workforce development opportunities through targeted training and curriculum programs. This institute will be established in early 2016, with cooperative agreement funds programmed in this budget through FY 2020. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 7 - Advanced Tissue Biofabrication Manufacturing Innovation Institute (ATB-MII) ***Description:*** This institute is intended to advance state-of-the-art human tissue manufacturing innovations in cell and biomaterial processing, bioprinting, automation and non-destructive testing technologies. The motivation is to increase U.S. competitiveness in advanced tissue biofabrication manufacturing by encouraging insertion of disruptive technologies into multiple biotechnology sectors, streamlining integrated testing technologies and ultimately reducing the barrier to entry for new inventors. The goal is to establish a collaboration that will mature tissue-related technology across a range of manufacturing readiness levels (MRL) 4-7, enabling post-delivery assurance of tissue identity, viability, function, and efficacy. This Institute will bring together the diverse and currently fragmented collection of industry practices and institutional knowledge across many disciplines (cell biology, bioengineering, materials science, analytical chemistry, robotics, and quality assurance). Scaling up to commercial level production of tissues will require manufacturing and process automation suitable for living cells, as well as testing and preservation methods appropriate for tissue-based products with limited shelf-life and a narrow window of efficacy. Technical focus at a minimum will be comprised of four thrust areas: 1) Cell & Material Selection & Sourcing; 2) Biofabrication Platforms; 3) Process Design and Automation; 4) Tissue Finishing and Testing Technologies This institute was established in late 2016. Technology Investment Agreement funds are programmed in this budget from FY 2016 through FY 2022. ***FY 2018 Plans:*** Continue to expand the membership and refine core investment areas supporting the innovation ecosystem. Initiate two rounds of applied R&D project calls in core areas. Execute workforce development projects. ***FY 2019 Base Plans:***	20.000	20.000	19.159	0.000	19.159

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue to expand the membership and refine core investment areas supporting the innovation ecosystem. Initiate two rounds of applied R&D project calls in core areas. Execute workforce development projects. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:*** N/A					
Title: Institute 8 - Robotics in Manufacturing Environment (RiME) ***Description:*** The motivation for this Manufacturing Innovation Institute is to improve U.S. competitiveness in manufacturing through advancements in the smart collaborative robotic field. This technology has the potential to level the manufacturing playing field with competing low labor cost economies, with decreased manufacturing cost, better quality and timely reaction to changes needed by the customer. Smart, collaborative robotics can also enable "batch of one" production, also known as mass customization. The technologies developed in this institute will be primarily focused in making advanced manufacturing more competitive, addressing DoD needs, and contribute to improving prosperity in the United States. The Institute will focus on technology areas such as human robot interaction, adaption, learning, manipulation, autonomy, mobility and perception. This institute will be established in FY 2017. Cooperative Agreement/Technology Investment Agreement funds are programmed in this budget from FY 2017 through FY 2022. ***FY 2018 Plans:*** Continue to expand the membership and refine core investment areas supporting the innovation ecosystem. Initiate two rounds of applied R&D project calls in core areas. Execute workforce development projects. ***FY 2019 Base Plans:*** Continue to expand the membership and refine core investment areas supporting the innovation ecosystem. Initiate two rounds of applied R&D project calls in core areas. Execute workforce development projects. ***FY 2019 OCO Plans:*** None ***FY 2018 to FY 2019 Increase/Decrease Statement:***	20.000	20.000	19.400	0.000	19.400

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A					
Accomplishments/Planned Programs Subtotals	126.892	114.647	92.309	0.000	92.309

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Each Manufacturing Innovation Institute is established through a competitive selection process. The executing military department or agency, in close and continuous coordination with OSD ManTech, publishes a formal solicitation (funding opportunity announcement) for proposals describing the scope of required activities and extensive proposal evaluation criteria. Non-Profit Organizations (including universities) are eligible to bid, and each bidder forms a broad consortium of industry and academic partners. The executing military department or agency, in close coordination with OSD, uses a team of government experts to evaluate each proposal against the evaluation criteria and selects a winning consortium. The final terms of the cooperative agreement/technology investment agreement between the selectee and the federal government are then negotiated and the CA or TIA is signed. Throughout and after completion of this process, the federal government makes clear that members of non-selected teams are encouraged to join the selected consortium as conditions permit.

E. Performance Metrics

Assessing the performance of the DoD-led manufacturing institutess, part of the whole-of-government Manufacturing USA Program, requires a multi-faceted view of ‘performance,’ given the program’s layered base of DoD, government-wide, and national level public-private stakeholders and interests. Notwithstanding this complexity, the Department is careful to maintain orientation with the DoD ManTech program’s statutory goals and objectives and has concluded that those requirements are highly complementary to, and supportive of, the broader national goals of the Manufacturing USA Program as laid out in the Revitalize American Manufacturing and Innovation (RAMI) Act of 2014. Performance relative to both sets of goals/objectives is necessarily measured in both qualitative and quantitative terms, and many of the institutes accomplishments previously addressed represent rich and highly descriptive qualitative and quantitative measure of program performance. The Department actively reviews or oversees the review of institute metrics at four levels: 1) the overall Manufacturing USA network level (this is done in coordination with the DoD’s Manufacturing USA interagency partners), 2) at the DoD/funding agency level (per the statutory requirements of DoD ManTech Program), 3) at the individual institute level (in coordination with each institute), and 4) at the specific technology project level (via DoD technical expert involvement in the institutes). Broadly, the institutes themselves are charged by the DoD, the Administration and Congress with ensuring that key elements of their innovation ecosystems will be matured and made widely available by fostering collaborations between appropriate elements of that ecosystem. The following four categories of metrics have emerged as common focus areas:

1. Impact on U.S. Innovation Ecosystem
2. Financial Leverage/Sustainability
3. Education and Advanced Manufacturing Workforce Development

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 350 / *Manufacturing Innovation Institutes*

4. Technical Advancement

Specific metrics and the annual cycle for measuring progress against benchmarks are developed for each institute consortium and reflect that institute's unique technology capability, expertise, and organizational structure. The Department strives to ensure that the assessment process captures and articulates the benefits to national security based upon technological advancements and the industrial base.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 607 / *National Security Technology Accelerator Program*

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
607: *National Security Technology Accelerator Program*	0.000	25.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

Note

This is a congressional add transferred from Defense Logistics Agency's Generic Logistics R&D Technology Demonstrations Program, PE 0603712S00

A. Mission Description and Budget Item Justification

This is a congressional add transferred from Defense Logistics Agency's Generic Logistics R&D Technology Demonstrations Program, PE 0603712S00

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: National Security Technology Accelerator ***Description:*** This is a congressional add transferred from Defense Logistics Agency's Generic Logistics R&D Technology Demonstrations Program, PE 0603712S00 ***FY 2018 Plans:*** This is a congressional add transferred from Defense Logistics Agency's Generic Logistics R&D Technology Demonstrations Program, PE 0603712S00 ***FY 2019 Base Plans:*** None ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** None	0.000	0.000	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	0.000	0.000	0.000	0.000	0.000

	FY 2017	FY 2018
Congressional Add: National Security Technology Accelerator	25.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603680D8Z / *Defense Wide Manufacturing Science and Technology Program*	**Project (Number/Name)** 607 / *National Security Technology Accelerator Program*

	FY 2017	FY 2018
FY 2017 Accomplishments: This is a congressional add that moved over from an R&D PE. ***FY 2018 Plans:*** This is a congressional add that moved over from an R&D PE.		
Congressional Adds Subtotals	25.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

None

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*

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	244.377	54.279	57.876	48.338	-	48.338	51.309	52.137	52.962	53.795	Continuing	Continuing
795: *Emerging Capabilities Technology Development*	244.377	54.279	39.876	40.338	-	40.338	41.309	42.137	42.962	43.795	Continuing	Continuing
713: *High Energy Laser*	0.000	0.000	18.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
717: *Red Teaming*	-	0.000	0.000	8.000	-	8.000	10.000	10.000	10.000	10.000	Continuing	Continuing

Note

The Emerging Capabilities Technology Development (ECTD) Program Element (PE) produces risk-reducing, conceptual and operational prototypes and conducts demonstrations of emerging technologies to support the priorities of the new Under Secretary of Defense for Research and Engineering (USD(R&E)). ECTD supports the USD(R&E) with experimentation and longer-term, mission-focused capability development that crosses functional domains and enhances warfighter technical superiority, adaptability, and resilience. The office collaborates with government labs, academia, and industry to execute projects that target specific mission capability gaps identified by the Combatant Commands (CCMDs), the Joint Staff, and senior leadership in the Office of the Secretary of Defense.

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The ECTD funding supports projects that reduce technology risk of emerging capabilities by advancing conceptual and operational prototypes in support of near- and mid-term operational engagements and stability operations. With an emphasis on interagency and joint partnerships, ECTD matures capability options to anticipate and inform formal joint and interagency requirements and acquisition processes. Individual projects generally span one to three years through efforts that emphasize affordability, typically at a cost of less than $6.000 million. The ECTD program focuses on rapid prototyping of emerging technologies to accelerate capabilities to the joint warfighter, including electromagnetic spectrum-agile capabilities; multi-domain, autonomous systems; counter-weapons of mass destruction capabilities; and, dismounted soldier systems. Project selection is guided by Department-level strategies and priorities, such as the Chairman's Gap Assessment, USD(R&E) strategic guidance, and CCMD Integrated Priority Lists (IPLs).

In anticipation of a heightened emphasis by the new USD(R&E) on outpacing threats and seizing technical opportunities, ECTD is structured to mature emerging technologies and highlight their military capabilities through joint demonstrations and ECTD sponsored venues for defense-wide experiments and demonstrations. These include Stiletto, a maritime experimentation and demonstration platform; Thunderstorm, an intelligence, surveillance, and reconnaissance venue; and, other tailored experimentation and demonstration events. Together, these events enable newly-developed capabilities to be showcased in realistic environments with operational user involvement. The ECTD program supports red teaming efforts to identify vulnerabilities in emerging technologies early, ensuring follow-on systems are resilient to adversaries.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*

In response to changing Department of Defense priorities, two new project lines are being added to the ECTD PE. The high energy laser (HEL) project will begin development work to integrate a HEL onboard an AC130 aircraft. This will enhance special operations forces' ability to provide precision fires. The red teaming project line will assess the susceptibility and vulnerability of emerging technologies. This will enable the new Office of the Under Secretary of Defense for Research and Engineering to make informed decisions on building new capabilities.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	49.895	57.876	48.037	-	48.037
Current President's Budget	54.279	57.876	48.338	-	48.338
Total Adjustments	4.384	0.000	0.301	-	0.301
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	6.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.548	-			
• FFRDC Transfer	-0.061	-	-	-	-
• Other Internal Baseline Adjustment	-0.007	-	0.572	-	0.572
• Economic Assumption	-	-	-0.271	-	-0.271

Change Summary Explanation

The FY 2017 funding increase of $6.000 million was provided by Congress to support high energy density composites and air base resiliency.

The FY 2019 baseline adjustment reflects the net of other DoD requirements and funding for the Red Teaming project code.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 795 / *Emerging Capabilities Technology Development*

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
795: *Emerging Capabilities Technology Development*	244.377	54.279	39.876	40.338	-	40.338	41.309	42.137	42.962	43.795	Continuing	Continuing

A. Mission Description and Budget Item Justification

ECTD funding supports projects that reduce technology risk, create capabilities across functional domains, and prototype technologies that deliver the capabilities needed to enhance warfighter adaptability and resilience. Individual projects typically cost less than $6.000 million and focus on rapid prototyping and demonstrations of emerging technologies. ECTD funding also supports demonstration venues that develop and mature emerging technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Voidstar ***Description:*** This project demonstrated and delivered advanced Electronic Warfare (EW) capabilities using tactical software-defined radio (SDR) technology. The capabilities and radio are vertically-scalable to operate on platforms with varying size, weight, and power (SWaP) constraints; and, horizontally-scalable to coherently operate across disparate platforms. The Voidstar project culminated in a successful demonstration of the capability and transitioned to the Air Force. Details of this project are classified.	2.504	-	-
Title: Long Range Engagement Weapon (LREW) ***Description:*** This project completed the engineering and design work required to rigorously demonstrate the feasibility of a multi-role, long-range interceptor missile for maintaining air dominance. The LREW concept combines proven components from existing missile systems with new, innovative technologies to provide a leap-ahead increase in overall performance. Efforts included analysis validating systems design, wind tunnel testing, engineering assessments, and kill chain investigations to inform potential future programs for the Navy and Air Force. LREW products transitioned to the Air Force for further development. Details of this project are classified.	7.686	-	-
Title: Raven Flash ***Description:*** The Raven Flash project will develop and demonstrate an adaptable, agile, Electronic Warfare capability using integrated source system components and associated high performance materials. FY 2017 efforts included development and characterization of system components and baseline effects testing using surrogate electronic system testbeds. Details of this project are classified. ***FY 2018 Plans:***	2.222	3.063	3.480

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Building on FY 2017 accomplishments, Raven Flash will continue the development and integration of component sub-systems culminating in a “brass-board” system demonstrator. A functional assessment of the Raven Flash architecture in a laboratory environment against challenging classes of surrogate electronic systems will be conducted. ***FY 2019 Plans:*** Raven Flash will develop a fully integrated, functionally-relevant prototype system. Activities to design, fabricate, assemble, and test the prototype will be conducted. The relative performance of the system will be characterized, assessed, and validated against a selected high-fidelity, relevant electronic system in a laboratory environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Raven Flash level of effort remains largely the same from FY 2018 to FY 2019. Final integration and testing occurs in FY 2019 and results in higher material and testing costs, reflected in the $0.420 million increase.			
Title: Advanced Electronic Warfare Laboratory (AEWL) ***Description:*** This project will develop an extensible Advanced Electronic Warfare Laboratory (AEWL) technical framework that can be replicated at multiple Service labs and government research and development facilities. The AEWL concept will support technical risk assessments of emerging blue force electronic warfare (EW) subsystems and system prototypes in a realistic electromagnetic spectrum (EMS) environment. AEWL will support hardware-in-the-loop testing, enabling the Department of Defense to evaluate the effectiveness of prototype systems or subsystems against realistic signals early in development. This effort includes the hardware and software implementation of the first instantiation of the AEWL technical framework. In FY 2017, AEWL designed and procured final hardware components and subsystems and completed installation and integration of several prototype subsystems. ***FY 2018 Plans:*** This project will complete final integration of the hardware subsystems and acceptance testing of the integrated AEWL. Once operational, the initial instantiation of AEWL will be transitioned to the U.S. Army for evaluation and use. Technical data packages will also be available to the other Services. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This project will be completed in FY 2018.	8.167	2.150	-
Title: Advanced Data Link for Unmanned Aerial Systems ***Description:*** This project developed an advanced, extended-range datalink for tactical unmanned aerial systems (UAS). The project culminated in a final capability demonstration. This capability expands warfighters’ battlespace awareness by increasing	1.000	-	-

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
the range of existing theater surveillance assets. The prototype system transitioned to the U.S. Navy for further development and integration into an existing tactical UAS program. Details are classified.			
Title: Advanced Composite Flywheel Energy Storage and Power System ***Description:*** This project developed and demonstrated a prototype Advanced Composite Flywheel Energy Storage and Power System Module (AESPM); and, evaluated its potential application for underwater systems and humanitarian assistance missions. With FY 2017 funding, this project incorporated the AESPM into a ruggedized, transportable configuration with flexible input and output power capabilities for a multitude of potential DoD missions. This technology area is a congressional interest item and additional resources were provided above the President's budget request.	3.500	-	-
Title: Air Base Resilience Sensor ***Description:*** This project developed an advanced sensor to enhance detection and tracking of threat systems. Previous funding developed an advanced integrated sensor chip assembly (SCA) prototype. FY 2017 funding integrated the SCA into a sensor system prototype for demonstration in an operationally-relevant environment. This technology area is a congressional interest item and additional resources were provided above the President's budget request. Details of this project are classified.	2.500	-	-
Title: X-Lab ***Description:*** X-Lab developed a robust architecture and analytic toolset to monitor and exploit numerous extremely large data sets and provided a flexible means for addressing evolving strategic threats. The delivered X-Lab system enables monitoring of adversary activities to identify anomalies and recognize subtle threat activity patterns. Initial work focused on leveraging data sets to provide early indications of activities leading to a large-scale terrorist or state-sponsored attack. Using expanded live and archived classified and unclassified data sets, X-Lab can address other Combatant Commands' problem sets. Early detection and warning of precursor activities can enable early intervention, such as queuing of intelligence, surveillance, and reconnaissance (ISR) capabilities; and, earlier deployment of countermeasures. X-Lab transitioned to a classified operational user. Details of this project are classified.	4.762	-	-
Title: Quartz Disk Resonator Gyroscope (QDRG) ***Description:*** Quartz Disk Resonator Gyroscope (QDRG) will demonstrate a next-generation low size, weight, power, and cost (SWaP-C), navigation-grade gyroscope for position, navigation, and timing (PNT) applications. This micro-electromechanical systems (MEMS) technology will enable precision targeting, navigation, and tracking with a reduced error in Global Positioning System (GPS) denied environments. The projected SWaP will enable the technology to be incorporated into hand-held and small autonomous systems across the Services. FY 2017 efforts included successful risk-reduction activities to demonstrate that high-	2.400	1.000	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
quality quartz disks can be reliably manufactured. The project will demonstrate an integrated, miniature gyroscope prototype in FY 2019 for inclusion into targeting control systems, laser rangefinders, and inertial measurement units. ***FY 2018 Plans:*** Building on FY 2017 accomplishments, QDRG will etch optimized quartz disks, design and fabricate control electronics, and vacuum package the resonator for laboratory test and validation. FY 2018 development and testing will allow for package design modifications before integration into an internal navigation system (INS). With FY 2018 funds, QDRG will complete package design and integration to demonstration critical performance parameters. The final prototype can be leveraged as a north-finding system or integrated with a MEMS accelerometer to demonstrate a navigation-grade INS. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** QDRG will be completed early in FY 2019.			
Title: Advanced Wide Area Motion Imagery (WAMI) ***Description:*** The Advanced Wide Area Motion Imagery project developed and demonstrated a reduced size, weight, and power (SWaP), day/night WAMI capability that is compatible with multiple manned and unmanned platforms across the Department of Defense (DoD). The advanced WAMI project developed the overall system design in FY 2017 completing both the preliminary design review (PDR) and critical design review (CDR) milestones. Using FY 2017 funds, work continues in FY 2018 to complete the prototype unit and conduct flight testing on a surrogate platform for U.S. Southern Command. After successful testing, the sensor prototype will transition to U.S. Army Special Operations Command for integration with fixed-wing unmanned aerial vehicles.	2.600	-	-
Title: Spectral Exploitation Camera for Targeting and Reconnaissance (SPECTRE) ***Description:*** The Spectral Exploitation Camera for Targeting and Reconnaissance (SPECTRE) project will develop and demonstrate a greatly reduced size, weight, and power (SWaP) hyperspectral imaging (HSI) capability that is compatible with multiple manned and unmanned platforms across the Department of Defense (DoD). The SPECTRE prototype will provide the ability to perform stand-off detection of materials or targets of interest. Initial efforts focused on the system design, modeling, and testing of various high risk design aspects. SPECTRE completed both preliminary design review (PDR) and critical design review (CDR) milestones in FY 2017. Additional project work includes design of a first-in-its-class, dual-field-of-view telescope with the ability to change optical path and field-of-view to adjust for off-nadir imaging. To accommodate this telescope, a larger and more robust pointing and stabilization mirror will be designed along with a customized pod to enable integration with unmanned platforms. ***FY 2018 Plans:***	3.500	1.500	-

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
In FY 2018, designs will continue and the telescope and the pod will begin construction, integration, and lab testing. FY 2018 will complete the development and build efforts for SPECTRE leading to a flight test in FY 2019 and planned transition to a deployed unmanned aerial system. This effort also informs Program Objective Memorandum (POM) efforts for two Army program of record aerial systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This project will be completed in FY 2018.			
Title: Distributed Collaborative Electronic Warfare & Radar (DISCOVER) ***Description:*** The Distributed Collaborative Electronic Warfare & Radar (DISCOVER) project will develop and demonstrate an integrated, multi-function, net-centric capability to support multiple Radio Frequency (RF) concepts of operation (CONOPs) in a small radio form factor. The prototype software-defined radio (SDR) will provide the dismounted warfighter with simultaneous robust voice and data communications, collaborative electronic warfare (EW), and distributed radar in an integrated capability. DISCOVER activities in FY 2017 included project design and modeling, and procurement of long lead-item components. ***FY 2018 Plans:*** In FY 2018, DISCOVER will develop demonstration CONOPs and system-level specifications for the FY 2019 demonstration. The project will also design and prototype RF subsystem hardware, develop EW and radar algorithms, and assess hardware performance. ***FY 2019 Plans:*** To support a FY 2019 multi-function (radar, EW, and communications) field demonstration, DISCOVER will integrate and test final RF hardware and antennas, complete algorithm development, and integrate a robust communications capability with the RF hardware. DISCOVER will transition to Marine Corps for initial demonstration and CONOPS experimentation followed by continued development by the U.S. Army. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** DISCOVER efforts conclude at the end of FY 2019 with a demonstration of an integrated, multi-function, net-centric capability. The majority of hardware and software development, integration, and testing occurs during FY2019 with a surge during the final quarter to support a field demonstration.	1.638	1.300	1.803
Title: Compact Adaptable Ballistic Technology (CAB-T) ***Description:*** The Compact Adaptable Ballistic Technology project will integrate lightweight materials and simplified cycling to provide compact kinematic performance in an adaptable design. The demonstrated prototype will achieve a modular ballistic system in a compact form factor to enable joint users to rapidly adapt to mission requirements. CAB-T assessments in FY 2017 included the effects of material properties, mechanical interaction, operating pressure, and cartridge-mechanism interactions.	1.500	1.000	0.800

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: In FY 2018, CAB-T will develop and integrate custom components, assess user interface, and validate compact ballistic technology modeling. Subsystem laboratory testing will validate CAB-T modeling. ***FY 2019 Plans:*** Final integration of compact ballistic technology with CAB-T user interface will be completed. CAB-T prototype and final assessment with technical data package will transition to a classified user. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** CAB-T efforts will be completed at the end of FY 2019 and the prototype will transition for further development and sustainment by the user. Due to the mid-year transition, CAB-T has a reduced level of effort for FY 2019.			
Title: Thunderstorm ***Description:*** The Thunderstorm demonstration venue examines emerging technologies and prototypes through a series of technology demonstrations, experiments, vignettes, and related activities. Thunderstorm provides the Department of Defense (DoD) and interagency partners with an opportunity to identify and evaluate new and emerging technologies both from commercial and government sectors. Operational users leverage Thunderstorm to experiment with mature and emerging commercial technologies that may meet mission-critical gaps. In addition, Thunderstorm provides an opportunity for small businesses and non-traditional technology developers to demonstrate capabilities in operationally relevant scenarios while interacting with operational commands and other government personnel. Thunderstorm demonstration objectives, performance measures, lessons learned, post-demonstration assessments, and data evaluations serve to identify new capabilities and new ways to employ existing capabilities. Thunderstorm annually features approximately 55 technologies resulting in about $3.000 million in cost avoidance. In FY 2017, Thunderstorm demonstrations and experimentation focused on port security, dense urban and subterranean warfare, and maritime-to-shore access control; and, demonstrated 42 technologies to representatives from 30 Department of Defense and interagency organizations. ***FY 2018 Plans:*** Building on previous experience, three Thunderstorm demonstrations are planned for FY 2018. Focus areas will include dense urban environments and subterranean warfare, integrated bridge technologies, metamaterials, and other priorities identified through engagement with stakeholders. ***FY 2019 Plans:*** Thunderstorm's focus will continue to reflect the most pressing challenges to DoD and provide a venue to explore new and innovative technological solutions. Focus areas will be based on needs and priorities identified through engagement with	2.500	2.500	2.500

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
stakeholders in the Military Services, the Combatant Commands, the U.S. Coast Guard, the Intelligence Community, and other operational users.			
Title: Stiletto Maritime Demonstration Program ***Description:*** Stiletto is a maritime technology demonstration, experimentation, and assessment venue for exploring emerging technologies and prototypes. The program is guided by focus areas identified by Combatant Commands, military Services, other defense organizations, and interagency partners. Stiletto includes an experimental, all carbon fiber 88-foot boat that serves as a maritime demonstration platform. The Stiletto program also includes other maritime platforms to assist in the exploration, assessment, and development of prototypes. Stiletto supports the rapid discovery and transition of emerging technologies across the range of military operations, thereby increasing the speed of response to emerging threats. The boat supports special operations forces, expeditionary forces, and interagency users by experimenting with new technologies and exploring their military utility to reduce the risk of emerging technologies and concepts of operation. The Stiletto Maritime Demonstration Program offers a streamlined experimentation and demonstration process that encourages system developers to engage directly with the warfighter in the maritime environment, and to rapidly adapt new technologies to meet operational needs. Stiletto annually demonstrates approximately 65 technologies resulting in about $4.000 million in cost avoidance. In FY 2017, Stiletto conducted 14 demonstration and experimentation events focused on maritime electro-optical and infrared surveillance; counter unmanned underwater vehicles (C-UUV); and, maritime intelligence, surveillance, and reconnaissance from unmanned aerial vehicles. These events demonstrated 78 emerging technologies to 21 Department of Defense and interagency organizations. The Stiletto vessel is home-ported in Norfolk, Virginia. ***FY 2018 Plans:*** The Stiletto Maritime Demonstration Program will continue engagement with operational partners to determine urgent demonstration requirements for FY 2018. Four capability demonstrations are planned for FY 2018. These demonstrations will focus on operations in megacities, non-lethal vessel stopping, military information support operations (MISO), and improved decision making for autonomous vehicles. ***FY 2019 Plans:*** The Stiletto Maritime Demonstration Program will continue to focus on emerging capabilities and threats. Engagement with stakeholders from the Military Services, the Combatant Commands, the U.S. Coast Guard, the Intelligence Community, and other operational users will identify needs and priorities to guide capability demonstrations.	2.500	2.500	2.500
Title: Low Cost Innovative Projects ***Description:*** Emerging Capabilities Technology Development (ECTD) funding supports projects requiring less than one million dollars for execution. In FY 2017, ECTD selected, executed, and transitioned low cost innovative projects including:	5.300	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Advanced Digital Radio Frequency Memory (DRFM): A coherent countermeasure (CoCM) prototype using photonic technology to achieve a wide operational bandwidth, fast frequency tuning, and wide instantaneous bandwidth. Additionally, the prototype provided sophisticated digital signal processing and generation of advanced CoCM waveforms and techniques. The advanced DRFM transitioned to Naval Air Systems Command for further development. • Persistics Software Enhancement: This project developed and delivered systems that automatically integrate and analyze open source imagery data to predict adversary behavior and track weapons of mass destruction in denied areas. The capability transitioned to U.S. Pacific Command and U.S. Special Operations Command. Further project details are classified. • Multi-Thread Experiment (MTX): Enabled concept experimentation with autonomous unmanned vehicles (UxVs) in an operationally-relevant, multi-domain environment. Efforts focused on collaboration via a distributed control network, which parses sensing, control, navigation, and communication information through a network to achieve mission objectives. • Robust Airworthy Optical Systems: This project integrated government-developed optical subsystems to inform design of a sub-scale operationally representative solid state laser (SSL) weapon system. Related efforts will validate and test design performance in a simulated airborne flight environment. • Low-Cost Precision Intercept: This project developed and demonstrated an ultra-low size, weight, power, and cost terminal guidance seeker. The seeker was paired with a small unmanned aerial system to demonstrate a low-cost, long-range, terminally guided platform. The capability transitioned to U.S. Special Operations Command for further development. • United Nations (U.N.) Peacekeeping Operations (PKO) Technology: A pilot project demonstrated the utility of integrating proven Department of Defense (DoD) technologies to enhance multilateral peacekeeping operations and improved DoD collaboration with the U.N. and other peacekeeping stakeholders. U.N. PKO prototypes transitioned to deployed forces in the U.S. Africa Command and U.S. Central Command areas of responsibility.			
Title: Conceptual Prototyping Focus Area ***Description:*** This effort focuses on cost-effective, limited-duration activities to design, develop, and deliver prototypes of cutting-edge land, sea, undersea, air, and space systems. Conceptual prototyping activities seek to rapidly develop and demonstrate asymmetric capabilities that can help maintain the U.S. competitive advantage. Selected projects provide an affordable venue to innovate new capabilities and increase speed to market through conceptual prototyping. These prototypes will be delivered to Joint Service users to evaluate operational capabilities and inform requirements and technical feasibility of future acquisition programs. Potential venues for prototype assessment include the Stiletto Maritime Demonstration Program, Thunderstorm integration exercises, and multi-domain demonstration venues across the Department of Defense (DoD). Development of advanced prototypes will involve partnerships with the Services, industry, academia, and non-traditional DoD partners. ***FY 2018 Plans:*** This focus area will be used to develop concepts and designs through conceptual prototyping that will result in asymmetric capabilities. While project determinations are generally made in the year of execution, projects to be considered will rapidly	0.000	3.110	3.800

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
mature capabilities that address DoD needs across multiple domains. Two to three prototype efforts are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** Projects will be selected in the year of execution and will support DoD research and engineering enterprise strategic priorities. Projects will focus on cost-effective, mission-focused efforts to design, develop, and deliver new concepts and technology prototypes aimed at supporting the Joint Force. Focus areas for prototyping projects include force protection, lethality, autonomous learning systems, manned-unmanned combat teaming, assisted human operations, warfighter resilience, command & control, mobility, and electronic warfare. Two to three prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Electromagnetic Spectrum Agility Focus Area ***Description:*** This focus area includes prototypes that create new concepts and capabilities which protect Department of Defense (DoD) systems and extend capability across the electromagnetic spectrum. DoD communication and sensing capabilities are increasingly compromised by congestion and spectrum loss, as is evidenced by the recent radio frequency (RF) spectrum auction and the spectrum relocation fund. In other operational environments, emergent electronic warfare (EW) threats, technologies, and tactics contest the use of the RF spectrum and erode U.S. capabilities in ways that are difficult to predict and counteract. This focus area helps address the dual challenges of anti-access and area denial though improved spectrum agility, allowing our forces to operate when and where they are needed. ***FY 2018 Plans:*** This focus area will develop concepts and designs through conceptual prototyping that will result in next-generation electronic warfare, communications, and RF sensing capabilities in one to three years. While project determinations are generally made in the year of execution, prototypes from this focus area will address spectrum sharing, spectrum relocation, and spectrum competition requirements; and, will be evaluated under the electromagnetic (EM) conditions expected in the U.S. and abroad. Two to three prototype efforts are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** Projects will be selected in the year of execution and will support DoD research and engineering enterprise strategic priorities. Selected projects will focus on cost-effective, mission-focused efforts to design, develop, and deliver new concepts and	0.000	3.610	4.064

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
technology prototypes aimed at protecting DoD systems and extending capabilities through agile electromagnetic spectrum prototypes. Two to five prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Distributed Sensing Concepts to Asymmetrically Counter Unconventional Weapons and Missile Threats Focus Area ***Description:*** This focus area addresses threats from weapons of mass destruction (WMD) and advanced cruise and ballistic missiles through low-cost, rapidly-deployed, distributed sensing concepts and enabling technologies. Projects leverage networked sensors and autonomous learning systems to asymmetrically defeat emerging threats. The focus area is aimed at developing prototype technologies and demonstrations of distributed networked sensors for: enhanced detection capabilities for chemical, biological, radiological, nuclear, and high yield explosives threats; persistent intelligence and target discrimination in anti-access/ area denial (A2/AD) environments; and, advanced sensors and sensor technologies for detection, tracking, and cueing missile defenses. ***FY 2018 Plans:*** Plans for FY 2018 include pursuing development of concepts and designs for low cost distributed sensing initiatives that will result in innovative prototype systems in one to three years. FY 2018 projects will include data mining for indications and warnings of a WMD or missile attack and unattended measurement and signature intelligence (MASINT) sensors to provide situational awareness of WMD activities in denied areas. One to two prototype efforts are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** Projects will be selected in the year of execution. Projects to be considered will support DoD research and engineering enterprise strategic priorities and will focus on cost-effective, mission-focused projects to design, develop, and deliver new concepts and technology prototypes aimed at supporting the Joint Force with critical enablers in distributed networked sensors, unattended intelligence systems, force protection, and data fusion. Two to three prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.000	2.603	3.390

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Rapid Prototyping of Autonomous or Semi-Autonomous Systems for Human-Machine Combat Teaming Focus Area ***Description:*** This focus area addresses the need to develop new operational capabilities; speed up the observe, orient, decide, and act (OODA) loop; and, enhance situational awareness through the teaming of humans with autonomous or semi-autonomous robotic or software-enabled systems. Related capabilities that enable autonomy are multiplying due to sensors that can understand the environment and software algorithms that can make a decision or seek human assistance. The focus area is aimed at rapidly developing prototype technologies and demonstrations of systems to: semi-autonomously detect, identify, track, prioritize, and engage targets with operator determination; and, autonomously detect and classify threats then recommend defensive or offensive actions to the operator. ***FY 2018 Plans:*** Plans for FY 2018 include pursuing development of concepts and designs for human-machine teaming that will result in innovative concept of operations (CONOPS) and prototype systems in one to three years. FY 2018 projects will include autonomous threat classification, target tracking, and systems to recommended actions to operators. The focus will be on low-cost, innovative capabilities. One to two prototype efforts are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** FY 2019 projects will be selected in the year of execution. Projects to be considered will support DoD research and engineering enterprise strategic priorities and will focus on cost-effective, mission-focused projects to design, develop, and deliver new concepts and technology prototypes aimed at supporting the Joint Force with a focus on assisting human decisions through robotic and software controlled systems. The focus will be on low-cost, innovative capabilities. Two to three prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.	0.000	2.124	2.920
Title: Multi-domain Experimentation and Demonstration Focus Area ***Description:*** This new portfolio will focus on developing conceptual prototypes and demonstrating them at multiple venues to enhance the capabilities of multi-domain joint warfighters. ECTD sponsors experimentation and demonstration venues to asses these prototypes and other concepts identified by partners across the defense community. Venues and targeted	0.000	2.104	2.897

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
experimentation and demonstration events explore rapidly-developing aviation, maritime, and ground combat systems. Projects include development of prototypes and modifications of existing capabilities to address emerging challenges through relevant operational demonstrations. This focus area supports prototype development and targeted experimentation and demonstration activities. This focus area also complements related efforts through the new Red Teaming Project. ***FY 2018 Plans:*** Plans for FY 2018 include featuring new and adapted prototypes at demonstration and experimentation events. While project determinations are generally made in the year of execution, projects to be considered will look at opportunities to address emerging challenges through relevant operational demonstrations. Projects under consideration include low-cost, prototype systems with autonomous behaviors; weapon systems with increased lethality; force protection capabilities; experimentation with new logistical models; and advanced, distributed intelligence, surveillance, and reconnaissance sensors. One to two prototype efforts leading to a demonstration are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** FY 2019 projects will be selected in the year of execution. Projects to be considered will support DoD research and engineering enterprise strategic priorities and will focus on cost-effective, mission-focused projects to design, develop, and deliver new capabilities that transition through a demonstration event. Two to three prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Rapid Prototyping of Individual Warfighter Systems Focus Area ***Description:*** This portfolio will focus on expedited delivery of field-ready prototypes to directly support dismounted soldier systems. Projects include capabilities for human assisted operations that increase soldier performance, resiliency, lethality, mobility, energy, communications, and situational awareness. These systems will support the Joint Force and Combatant Command priorities, in addition to emerging needs and opportunities as they are identified. Technology development will counter emergent threats to the warfighter both while en-route to, and operating within, expeditionary environments alongside partners. ***FY 2018 Plans:*** Plans for FY 2018 include pursuing development of concepts and designs for individual warfighter systems that will result in innovative concept of operations and prototypes in one to three years. While project determinations are generally made in the year of execution, projects to be considered will look at dismounted soldier systems that support the Joint Force with capabilities	0.000	1.312	2.184

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
for human assisted operations to increase soldier performance, resiliency, lethality, mobility, energy, communications, and situational awareness. One to two prototype efforts are anticipated in FY 2018 leveraging Joint, Service, and interagency partnerships. ***FY 2019 Plans:*** FY 2019 projects will be selected in the year of execution. Projects to be considered will support DoD Research and Engineering Enterprise Strategic Priorities and will focus on cost-effective, mission-focused projects to design, develop, and deliver new concepts and technology prototypes for individual warfighter systems aimed at supporting the Joint Force. One to two prototype efforts are anticipated in FY 2019 leveraging Joint, Service, and interagency partnerships. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: India Science and Technology Focus Area ***Description:*** The India Science and Technology (S&T) Focus Area is a Secretary of Defense directed project designed to deepen defense cooperation between the U.S. and India. By sharing research resources, capabilities, and expertise, the United States and India can jointly develop the technological innovations needed to enable our defense industrial bases to support our militaries now and in the future. Further, development of vibrant S&T cooperation is a key step in building an enduring partnership. ***FY 2018 Plans:*** The India Science and Technology Focus Area and related funding will continue to develop and execute cooperative S&T projects. Additional cooperative S&T areas targeted include: munitions development, advanced manufacturing, micro-power grids, and other identified project areas. In FY 2018, funding will be transferred from Joint Capability Technology Demonstration (JCTD) (Program Element 0603648D8Z) to better enable alignment and execution of the allocated funds. ***FY 2019 Plans:*** FY 2019 projects will be selected in the year of execution. Projects to be considered will support DoD Research and Engineering Enterprise Strategic Priorities that can be jointly developed through cooperative S&T projects. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019.	-	10.000	10.000
Accomplishments/Planned Programs Subtotals	54.279	39.876	40.338

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 795 / *Emerging Capabilities Technology Development*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

In FY 2019, generic performance metrics applicable to Emerging Capabilities Technology Development include the DoD Strategic Performance goal to transition 40 percent of completing demonstration programs per year. In addition, project completions and success are monitored against schedules and deliverables stated in the proposals and statements of work. The metrics include items such as target dates, production measures, performance metrics, and demonstration goals. In FY 2017, Emerging Capabilities Technology Development achieved a transition rate of approximately 70 percent.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 713 / *High Energy Laser*

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
713: *High Energy Laser*	0.000	0.000	18.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This initiative supports the U.S. Special Operations Command's (USSOCOM) effort to explore the operational capability for an AC-130 modified with a high energy laser (HEL). This funding enables analysis and risk reduction efforts to accelerate development of a HEL weapon system for USSOCOM missions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: AC-130 High Energy Laser (HEL) ***Description:*** This is a Department of Defense (DoD) directed effort initiated in FY 2018. This project includes risk reduction efforts to help accelerate development and operational demonstration of an electric laser with a rechargeable magazine on an AC-130. Activities covered by this funding include modeling, simulation, testing subsystems, and coordination with industry to support a subsequent USSOCOM HEL development program. Success for the subsequent program will be realized by integrating an HEL capability into the AC-130 precision strike package (PSP). The subsequent program will provide special operations forces with a materiel solution capable of addressing current warfighter gaps. ***FY 2018 Plans:*** Plans for FY 2018 include modeling, simulation, system design, and subsystem testing. Risk reduction efforts will include characterization of aircraft window optical effects and mitigation for optimal beam quality, validation of coelostat inertial stabilization and pointing (anti-jitter), and characterization of the bio-effects and hazards necessary to support program planning for the HEL system. After this initial risk reduction work the AC-130 HEL project will transition to the U.S. Special Operations Command for further development. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This project will be completed in FY 2018.	-	18.000	-
Accomplishments/Planned Programs Subtotals	-	18.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A – USSOCOM will support subsequent development and acquisition strategy.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 713 / *High Energy Laser*

E. Performance Metrics

USSOCOM defines specific performance metrics to evaluate the risk reduction effort and determine future investments. The project results are reviewed by a senior review group comprised of representatives from the Office of the Secretary of Defense, USSOCOM, other Combatant Commands, and outside subject matter experts. The ultimate measure of success is transition to the USSOCOM customer.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 717 / *Red Teaming*

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
717: *Red Teaming*	-	0.000	0.000	8.000	-	8.000	10.000	10.000	10.000	10.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Red Teaming project helps assess the susceptibility and vulnerability of emerging technologies and systems with high payoff potential to address current technology shortfalls or future capability gaps. The program supports field demonstrations and red-teaming to stress and assess emerging systems in key areas for gaining or maintaining overmatch earlier in the life-cycle. This project improves systems by reducing vulnerabilities and providing a holistic understanding of employment risks in operationally-representative environments and against potential threats. It informs requirements and helps accelerate acquisition pathways for joint missions. This effort leverages the innovative capabilities of the Federally Funded Research and Development Centers (FFRDCs), government laboratories, academia, and industry to develop a construct that current or future systems can be gamed against in a distributed, operationally-relevant environment employing traditional and non-traditional players. Deliverables will inform technology acquisition and new concept of operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Red Teaming in Support of Prototyping ***Description:*** The project funds red teaming and wargaming efforts to explore new capabilities in a competitive environment. Projects will explore unconventional approaches to counter DoD technologies through red teams, wargames, and studies that employ government laboratory scientists; subject matter experts; and, students of science, technology, engineering, and math (STEM) disciplines. Efforts range from distributed table-top games to simulated and live field exercises with non-traditional and operationally experienced participants including warfighters, scientists, engineers, students, and academics. Deliverables include recommendations on system operational employment, potential vulnerabilities, and likely countermeasures taken by the threat as well as potential counter-countermeasures to increase functionality or operational effectiveness of the system. The new Under Secretary of Defense for Research and Engineering (USD(R&E)) will leverage these products to inform how technologies and integrated systems can perform in hostile environments and develop new concepts of operations. ***FY 2019 Plans:*** The investment decisions for red teaming are made during the execution years in response to Department, CCMD, Service, and other government organization priorities and as new threats emerge or new opportunities are presented. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Red teaming in support of prototyping is a new project code for FY 2019 that informs the new Under Secretary of Defense for Research and Engineering.	0.000	-	8.000
Accomplishments/Planned Programs Subtotals	0.000	-	8.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603699D8Z / *Emerging Capabilities Technology Development*	**Project (Number/Name)** 717 / *Red Teaming*	

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Project performance metrics for FY 2019 will include specific details to each effort and include measures identified in individual project plans. Project completions and successes are monitored against schedules and deliverables stated in the proposals and statements of work. The metrics include items such as target milestone dates, specific performance measures, fielding dates, and demonstration goals.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*

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	292.110	63.177	71.832	76.514	-	76.514	75.088	76.791	78.286	80.007	Continuing	Continuing
470: *Strategic Environmental Research and Development Program (SERDP)*	292.110	63.177	71.832	76.514	-	76.514	75.088	76.791	78.286	80.007	Continuing	Continuing

A. Mission Description and Budget Item Justification

Congress established the Strategic Environmental Research and Development Program (SERDP) in 1990 (10 U.S.C. Section 2901-2904) to address Department of Defense (DoD) and Department of Energy (DOE) environmental concerns. It is conducted as a DoD program, jointly planned and executed by the DoD, DOE, and the Environmental Protection Agency (EPA), with strong participation by other Federal agencies, industry, and academia. SERDP`s objective is to improve DoD mission readiness and environmental performance by providing new scientific knowledge and cost-effective technologies in the areas of Environmental Restoration, Munitions Response, Resource Conservation and Resilience, and Weapons Systems and Platforms. SERDP does this by addressing high priority DoD environmental technology requirements. SERDP enhances military operations, improves military systems` effectiveness, enhances military training/readiness, sustains DoD’s training and test ranges and installation infrastructure, and helps ensure the safety and welfare of military personnel and their dependents by eliminating or reducing the generation of pollution and use of hazardous materials and reducing the cost of remedial actions and compliance with environmental laws and regulations. As a secondary benefit, SERDP helps solve significant national and international environmental problems. The keys to a growing list of SERDP technological successes are the ability to respond aggressively and proactively to priority defense environmental needs; the pursuit of world-class technical excellence; and an emphasis on constant technology transfer.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	65.078	71.832	77.756	-	77.756
Current President's Budget	63.177	71.832	76.514	-	76.514
Total Adjustments	-1.901	0.000	-1.242	-	-1.242
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• General Adjustment	-1.901	-	-	-	-
• Economic Adjustment (EA-008)	-	-	-0.630	-	-0.630
• Realignment to O&M (REPI Offset)	-	-	-0.612	-	-0.612

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*

Change Summary Explanation

Economic Adjustment (EA-008) is the comptroller budget decision that reflected OMB directed inflation adjustments. REPI Offset is an OMB decision that EI&E's REPI program be funded at a higher level.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*	**Project (Number/Name)** 470 / *Strategic Environmental Research and Development Program (SERDP)*

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
470: *Strategic Environmental Research and Development Program (SERDP)*	292.110	63.177	71.832	76.514	-	76.514	75.088	76.791	78.286	80.007	Continuing	Continuing

A. Mission Description and Budget Item Justification

Congress established the Strategic Environmental Research and Development Program (SERDP) in 1990 (10 U.S.C. Section 2901-2904) to address Department of Defense (DoD) and Department of Energy (DOE) environmental concerns. It is conducted as a DoD program, jointly planned and executed by the DoD, DOE, and the Environmental Protection Agency (EPA), with strong participation by other Federal agencies, industry, and academia. SERDP`s objective is to improve DoD mission readiness and environmental performance by providing new scientific knowledge and cost-effective technologies in the areas of Environmental Restoration, Munitions Response, Resource Conservation and Resilience, and Weapons Systems and Platforms. SERDP does this by addressing high-priority DoD environmental technology requirements. Technologies developed by SERDP enhance military operations, improve military systems' effectiveness, enhance military training/ readiness, sustain DoD's training and test ranges and installation infrastructure, and help ensure the safety and welfare of military personnel and their dependents by eliminating or reducing the generation of pollution and use of hazardous materials and by reducing the cost of remedial actions and compliance with environmental laws and regulations. As a secondary benefit, SERDP helps solve significant national and international environmental problems. The keys to a growing list of SERDP technological successes are the ability to respond aggressively and proactively to priority defense environmental needs; the pursuit of world-class technical excellence; and an emphasis on constant technology transfer.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Environmental Restoration ***Description:*** Environmental Restoration (ER) reduces DoD's liabilities by developing technologies for the cost-effective detection, characterization, containment, and remediation of contamination in soil, sediments, and water. ***FY 2018 Plans:*** New research initiatives will focus on the highest priority DoD requirements to reduce DoD's liabilities by developing technologies for the cost-effective detection, characterization, containment, and remediation of contamination in soil, sediments, and water. Specific Statements of Need were released that address 1) Improved Understanding of Per- and Polyfluoroalkyl Substance Source Zones, 2) In Situ and Ex Situ Remediation of Per- and Polyfluoroalkyl Substance Contaminated Groundwater, 3) Improved Understanding of Stormwater Impacts and Control on Sediment Recontamination and Recovery, and 4) Innovative Approaches for Monitoring and Implementing In Situ Remediation of Contaminated Aquatic Sediments. ***FY 2019 Plans:***	13.342	16.070	20.244

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*	**Project (Number/Name)** 470 / *Strategic Environmental Research and Development Program (SERDP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
New research initiatives will focus on the highest priority DoD requirements to reduce DoD's liabilities by developing technologies for the cost-effective detection, characterization, containment, and remediation of contamination in soil, sediments, and water. The planned increase will support projects related to the detection, quantification, treatment, and bioavailability of per- and polyfluoroalkyl substances. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased emphasis on PFOS and PFOA contamination on DoD installations.			
Title: Munitions Response (MR) ***Description:*** Munitions Response (MR) develops detection, classification, and remediation technologies for Unexploded Ordnance (UXO) to address the significant DoD liability in the Military Munitions Response Program. Investments are also made to improve active range clearance and to reduce generation of UXO during live fire testing and training operations. ***FY 2018 Plans:*** New research initiatives will focus on the highest priority DoD requirements in underwater UXO detection and protocols to reduce the costs associated with detecting, remediating, or managing UXO underwater. A specific Statement of Need was released that addresses Detection, Classification, and Remediation of Military Munitions Underwater. ***FY 2019 Plans:*** New research initiatives will focus on the highest priority DoD requirements in underwater UXO detection and protocols to reduce the costs associated with detecting, remediating, or managing UXO underwater with a focus on low-frequency acoustic imaging as a detection/classification system. Several projects will also be initiated aimed at constructing a physics-based model of munitions penetration on land to aid DoD project managers assess the suitability of competing remediation technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Several research projects in underwater acoustics have matured to the point of at-sea data collection. Funding increase required for these tests.	6.232	7.835	8.730
Title: Resource Conservation and Resilience (RC) ***Description:*** Resource Conservation and Resilience (RC) develops the science and technologies required to sustain training and testing ranges. ***FY 2018 Plans:*** New research initiatives will focus on the highest priority DoD requirements to develop the science and technologies required to sustain training and testing ranges. Specific Statements of Need were released to address 1) Advanced Approaches for	28.350	30.487	27.193

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*	**Project (Number/Name)** 470 / *Strategic Environmental Research and Development Program (SERDP)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Managing Individual Species and Ecosystems Across Jurisdictional Boundaries in a Non-Stationary World and 2) Climate Change Vulnerability Assessment of Major Habitats on and Around DoD lands. ***FY 2019 Plans:*** New research initiatives will focus on understanding wildfire initiation and spread to construct models to be used by installation natural resource managers in planning their managed fire programs, understanding the role of a changing environment on the management of threatened and endangered species, and resiliency initiatives for installations in the Arctic. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY-18 is the final year for a suite of projects focused to sustainability to sea-level rise. Reduced funding reflects the end of these projects.			
Title: Weapons Systems and Platforms (WP) ***Description:*** Weapons Systems and Platforms (WP) develops technologies and materials that reduce the waste and emissions associated with the manufacturing, maintenance, and use of DoD weapons systems and platforms to reduce future environmental liabilities and their associated costs and impacts. ***FY 2018 Plans:*** New research initiatives will focus on the highest priority DoD requirements to develop technologies and materials that reduce the waste and emissions associated with the manufacturing, maintenance, and use of DoD weapons systems and platforms to reduce future environmental liabilities and their associated costs and impacts. Specific Statements of Need were released to address: 1) Advancing Emulsion Science for Application in Armed Forces Vessels, 2) Non-Chemical, Non-Media Removal Process for Thick, Elastomeric Specialty Coatings Used on DoD Weapon Systems, 3) Systems Approaches in Propulsion and Explosives Toward Replacing Materials Such as Ammonium Perchlorate (AP), RDX, and TNT, and 4) Development of Agile, Novel Expeditionary Battlefield Manufacturing Processes Using Recycled and Reclaimed Materials. ***FY 2019 Plans:*** New research initiatives will focus on jet engine noise measurement and control, additive manufacturing for battlefield applications, sustainable pyrotechnics, and corrosion assessment and prediction applied to DoD weapon systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding reflects the planned jet engine noise projects.	15.253	17.440	20.347
Accomplishments/Planned Programs Subtotals	63.177	71.832	76.514

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603716D8Z / *Strategic Environmental Research and Development Program (SERDP)*	**Project (Number/Name)** 470 / *Strategic Environmental Research and Development Program (SERDP)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance in this program is monitored at two levels. At the lowest level, each of the more than 160 individual projects is measured against both technical and financial milestones on a quarterly and annual basis. At a program-wide level, progress is measured against DoD's environmental requirements and the development of technologies that address these requirements as well as the transition of these technologies to either to demonstration and validation programs or to direct use in the field.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* I BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603727D8Z I *Joint Warfighting Program*

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	35.896	4.581	6.349	5.992	-	5.992	6.095	6.269	6.432	6.569	Continuing	Continuing
727: *Joint Warfighting*	35.896	4.581	6.349	5.992	-	5.992	6.095	6.269	6.432	6.569	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Joint Warfighting Program (JWP) is a pivotal resource that synchronizes two Department-wide domains, military requirements and acquisition, with shared analyses and actionable assessments. JWP supports partnership for customers including joint command staffs, the Joint Staff, and OSD elements responsible for oversight of Component programs that equip forces for joint missions. The account underwrites analyses and studies, limited-scope experiments, and partnerships that define joint capability gaps and develop actionable requirements for follow-on acquisition efforts. JWP specifically aims to assist joint-end-users by analyses that identify essential capability improvements as actionable joint military needs expressed as specific Key Performance Parameters (KKPs) and Key System Attributes (KSAs). These analyses and assessments deliver independent perspectives on ways to align Service and Agency investments and potential solutions for capability gaps created by evolving threats not aligned to single Component missions. This program element plays a major role in portfolio assessments aiming to identify critical gaps between Service-generated capabilities and affordable joint solutions. JWP funds venues for demonstration of emergent technology-based prototypes that enable joint customers to draft requirements based on realistic understanding of feasible solutions. JWP also underwrites staff analyses in the Acquisition, Technology & Logistics staff of the Office of the Secretary of Defense (OSD). Working with Service, OSD, the Joint Staff and joint command counterparts, the AT&L staff performs portfolio assessments focusing on joint warfighting environments in the future.

Typical projects funded with JWP include independent analysis and translation of capability gap assessments into actionable military needs statements, identification of candidate solutions via experimentation, translation of solution concepts into field demonstrations, and remedy of joint capability gaps in partnership with Defense agents for doctrine changes and technology development. JWP resources support analytic expertise on joint issues. In this activity, JWP underwrites small grants to invigorate employment of experimentation and analysis, to formulate strategies to resolve joint capability gaps, and to stimulate participation in the Department enterprises for joint experimentation and joint capability development. JWP resources also supportthe development of tools supporting joint analytic efforts.
The JWP funds contributes resources to examination of potential remedies for joint mission capability gaps. In many cases, JWP funds initiatives for process improvements serving all Components, but aligned with no single Service or Agency. These early assessments and studies of potential capability gap solutions can accelerate engineering development, subsequent field experiments, and capability demonstrations in field conditions. JWP often represents the first effort to define integrated and innovative solutions across the range of Doctrine, Organization, Training, Material, Leadership and Personnel-Facilities through cross-cutting analysis and studies in partnership with the OSD staffs serving AT&L, Policy and with elements of the Joint Staff. It evolves analytic development of Joint Military Requirements addressing evolving threats / missions On a modest funding base, JWP forges collaborative analysis efforts across OSD and joint staffs to address tough DoD-wide issues like ISR, cyber, EW and UAS.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603727D8Z / *Joint Warfighting Program*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	7.848	6.349	7.039	-	7.039
Current President's Budget	4.581	6.349	5.992	-	5.992
Total Adjustments	-3.267	0.000	-1.047	-	-1.047
• Congressional General Reductions	-3.000	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.261	-			
• JWP Program Decrease	-	-	-1.010	-	-1.010
• FFRDC Reduction	-0.005	-	-	-	-
• Canceled account withhold	-0.001	-	-	-	-
• Economic Adjustment	-	-	-0.037	-	-0.037

Change Summary Explanation

Joint Warfighting Program decrease by $1M FY19-23

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603727D8Z / *Joint Warfighting Program*	**Project (Number/Name)** 727 / *Joint Warfighting*	

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
727: *Joint Warfighting*	35.896	4.581	6.349	5.992	-	5.992	6.095	6.269	6.432	6.569	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Joint Warfighting Program (JWP) is a pivotal resource that synchronizes two Department-wide domains, military requirements and acquisition, with shared analyses and actionable assessments. JWP supports partnership for customers including joint command staffs, the Joint Staff, and OSD elements responsible for oversight of Component programs that equip forces for joint missions. The account underwrites analyses and studies, limited-scope experiments, and partnerships that define joint capability gaps and develop actionable requirements for follow-on acquisition efforts.   JWP specifically aims to assist joint-end-users by analyses that identify essential capability improvements as actionable joint military needs expressed as specific Key Performance Parameters (KKPs) and Key System Attributes (KSAs). These analyses and assessments deliver independent perspectives on ways to align Service and Agency investments and potential solutions for capability gaps created by evolving threats not aligned to single Component missions. This program element plays a major role in portfolio assessments aiming to identify critical gaps between Service-generated capabilities and affordable joint solutions. JWP funds venues for demonstration of emergent technology-based prototypes that enable joint customers to draft requirements based on realistic understanding of feasible solutions.   JWP also underwrites staff analyses in the Acquisition, Technology & Logistics staff of the Office of the Secretary of Defense (OSD). Working with Service, OSD, the Joint Staff and joint command counterparts, the AT&L staff performs portfolio assessments focusing on joint warfighting environments in the future.

Typical projects funded with JWP include independent analysis and translation of capability gap assessments into actionable military needs statements, identification of candidate solutions via experimentation, translation of solution concepts into field demonstrations, and remedy of joint capability gaps in partnership with Defense agents for doctrine changes and technology development. JWP resources support analytic expertise on joint issues. In this activity, JWP underwrites small grants to invigorate employment of experimentation and analysis, to formulate strategies to resolve joint capability gaps, and to stimulate participation in the Department enterprises for joint experimentation and joint capability development. JWP resources also supportthe development of tools supporting joint analytic efforts.
The JWP funds contributes resources to examination of potential remedies for joint mission capability gaps. In many cases, JWP funds initiatives for process improvements serving all Components, but aligned with no single Service or Agency. These early assessments and studies of potential capability gap solutions can accelerate engineering development, subsequent field experiments, and capability demonstrations in field conditions. JWP often represents the first effort to define integrated and innovative solutions across the range of Doctrine, Organization, Training, Material, Leadership and Personnel-Facilities through cross-cutting analysis and studies in partnership with the OSD staffs serving AT&L, Policy and with elements of the Joint Staff. It evolves analytic development of Joint Military Requirements addressing evolving threats / missions On a modest funding base, JWP forges collaborative analysis efforts across OSD and joint staffs to address tough DoD-wide issues like ISR, cyber, EW and UAS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Support for Joint Capability Analysis ***Description:*** JWP resources are dedicated to analytic support for joint costumers and OSD staff elements to conduct joint capability analysis and joint customers. JWP supports joint capabilities by promoting analyses and assessments to address	3.447	3.100	4.000

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603727D8Z / *Joint Warfighting Program*	**Project (Number/Name)** 727 / *Joint Warfighting*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
specific joint challenges specific. It employs rigorous analysis and experimentation methodologies in support of specific mission assignments. It supports joint command identification of capability gaps and selectively funds limited objective experiments experiment to understand a concept or technology that addresses a specific joint mission challenge. JWP also resources analytic analysis and studies on joint issues.These early assessments and studies of potential capability gap solutions can accelerate engineering development, subsequent field experiments, and capability demonstrations in field conditions. JWP often represents the first effort to define integrated and innovative solutions across the range of Doctrine, Organization, Training, Material, Leadership and Personnel-Facilities through cross-cutting analysis and studies in partnership with the OSD staffs serving AT&L, Policy and with elements of the Joint Staff. ***FY 2018 Plans:*** Provide direct analytical support responding to emergent joint military staffs to identify capability gaps and military needs for material solutions. . Continue to partner with joint military staffs, encouraging experimentation cells to address mission capability gaps, explore potential solutions, and improve understanding of new technologies and concepts in response to evolving missions and military threats. Empower the joint military staffs to employ rigorous analysis and experimentation methodologies. ***FY 2019 Plans:*** Provide direct analytical support to address emergent joint military capability gaps and military needs. Continue to partner with joint military staffs, and encourage experimentation to address mission capability gaps, explore potential solutions, and improve understanding of new technologies and concepts in response to evolving missions and military threats. Empower the joint military staffs to employ rigorous analysis and experimentation methodologies to identify potential DOTMLPF remedies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Leadership decision to adjust funding to meet emerging requirements and needs to support priority mission requirements.			
Title: Analytic Development of Joint Military Requirements Addressing Evolving Threats / Missions ***Description:*** This segment underwrites innovative, responsive and timely analytic development of Joint Military requirements addressing evolving missions and threats. It supports joint capability development serving the needs of joint warfighters in partnership with senior acquisition staffs. It provides an independent source to examine potential remedies for mission capability gaps and can establish a framework for subsequent field experiments, capability demonstrations or accelerated acquisition. Joint warfare independent analysis often represents the first effort to define alternative solutions across the range of Doctrine, Organization, Training, Material, Leadership and Personnel-Facilities. On a modest funding base, JWP forges collaborative analysis efforts across OSD and joint staffs to address tough DoD-wide issues like ISR, cyber, EW and UAS. ***FY 2018 Plans:***	1.134	3.249	1.992

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603727D8Z / *Joint Warfighting Program*	**Project (Number/Name)** 727 / *Joint Warfighting*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This segment will provide independent analysis of joint issues and capability gaps. It will provide responsive and timely capability development pathways and recommendations for rapid acquisition, field experiments conducted by joint military staffs and units. It will provide an independent source for analysis and enabe capability development suitable for joint experimentation undertaken by joint authorities. ***FY 2019 Plans:*** This segment will provide independent analysis of joint issues and capability gaps. It will provide responsive and timely capability development pathways and recommendations for rapid acquisition, field experiments conducted by joint military staffs and units. It will provide an independent source for analysis and enable capability development suitable for joint experimentation undertaken by joint authorities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Leadership decision to adjust funding to meet emerging requirements and needs to support priority mission requirements.			
Accomplishments/Planned Programs Subtotals	4.581	6.349	5.992

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance is measured through metrics including (1) objective validation of enhanced CCMD capabilities to perform joint missions in their assigned theaters and areas of responsibility, (2) documented delivery effective joint operational concepts, (3) confirmed production of refined and validated capability descriptions.

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Exhibit R-2, **RDT&E Budget Item Justification:** PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603769D8Z / *Advanced Distributed Learning*

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	10.384	11.211	13.564	-	13.564	13.723	13.493	13.204	12.425	Continuing	Continuing
776: *Advance Distributed Learning (ADL)*	0.000	10.384	11.211	13.564	-	13.564	13.723	13.493	13.204	12.425	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Program Element (PE) describes the Advanced Distributed Learning (ADL) Initiative. This program was originally established in the 1990s in response to the NDAA (FY99, Section 378 of Public Law 105-261) and granted additional authorities via Executive Orders (e.g., EO 13111) and other supporting publications (e.g., 10 U.S. Code §2249d). Organizationally, this PE reports to the Deputy Assistant Secretary of Defense for Force Education and Training (DASD(FE&T)).

This PE provides policy oversight for distributed learning (e.g., online courses, smartphone-based learning, web browser–based simulations) and supports associated innovation, modernization, and coordination across DoD, Coalition partners (e.g., NATO), and other federal agencies. This work largely focuses on distributed learning interoperability (i.e., ensuring interagency technical and organizational systems function together) and helping agencies acquire new distributed learning capabilities effectively and cost-efficiency. Ultimately, this PE's work promotes personnel readiness, helping the right people to receive the right training and education, at the right time—at the right cost.

This PE's work falls into three interrelated categories: (1) Modernization, (2) Documentation, and (3) Coordination. The "modernization" work involves Advanced Technology Development (6.3) in technical areas such as e-learning, mobile learning, learner modeling and analytics, and software interoperability. These efforts inform the PE's "documentation" work, including the authoring and upkeep of technical guidance and policy documents, such as DoD Instruction 1322.26 ("Distributed Learning") and software interoperability specifications. Finally, the documentation work drives "coordination" efforts, which consist of implementation support and interagency/interorganizational coordination.

This PE's modernization investments are driven by requirements collected from the Defense ADL Advisory Committee, a working group of military personnel and DoD/federal civilians (at the O-6 and GS-15 level) who represent their agencies' distributed learning equities and are key stakeholders in shaping the direction of these agencies. These requirements are aligned to DoD/federal strategic direction, such as the Army Learning Concept for Training and Education for 2020–2040 (TP 525-8-2), Navy's Sailor 2025, and Air Force Strategic Master Plan, and they are considered against emerging industry trends and technologies.

This PE benefits DoD in three ways. (1) Interoperability: It strengthens interagency, interorganizational, and multinational interoperability by governing distributed learning interoperability policy, maintaining current technical reference guidelines, and fostering their implementation across communities of practice. (2) Efficiencies: It saves government resources by fostering unity of effort across DoD, other federal agencies, and Coalition Partners for distributed learning, eliminating duplications and identifying opportunities for interagency collaboration. (3) Learning Effectiveness: It helps improve training and education effectiveness by helping DoD, federal, and Coalition stakeholders acquire and implement emerging distributed learning capabilities effectively and cost-efficiently. In sum, this work supports the components' training and education missions, helping them increase personnel readiness while driving down training and education portfolio costs.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603769D8Z / *Advanced Distributed Learning*

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	11.211	11.157	-	11.157
Current President's Budget	10.384	11.211	13.564	-	13.564
Total Adjustments	10.384	0.000	2.407	-	2.407
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	10.384	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	-	-	2.407	-	2.407

C. Accomplishments/Planned Programs ($ in Millions)

	FY 2017	FY 2018	FY 2019
Title: Advance Distributed Learning (ADL)	10.384	11.211	13.564

Description: This PE serves as the innovation hub for distributed learning across the DoD and other government agencies, enabling innovation, finding efficiencies, informing stakeholders' modernization efforts, and fostering interoperability across defense, government, and industry. This program's R&D efforts improve efficiencies and reduce costs by reducing time spent in face-to-face instruction, allowing more time for practical application and repetition; increasing interoperability, which enables discovery, retrieval, and reuse of distributed learning content; and researching and prototyping methods of distributed learning with superior motivational and learning outcomes.

FY 2018 Plans:

Total Learning Architecture – All of the U.S. Services, Joint Staff, and many other federal programs have released publications calling for a modern "learning ecosystem" comprised of interconnected learning opportunities, supported by technology, driven by data, and integrated with other talent management capabilities. This program is supporting its development by investigating the specifications and web-based digital services needed to make training and education technologies interoperable. In FY17, an early "Total Learning Architecture" prototype was tested with 75 Special Operators at Ft. Bragg. In FY18, this project will enter its second phase of development and will include additional empirical testing.

Learning Data – In FY17, this program led a revision to DoD Instruction 1322.26, after extensive coordination with the Services and Joint Staff. The revised Instruction recommends the use of the Experience Application Programming Interface (xAPI), a technical specification that enables data exchange across training and education technologies. In FY18, this program will continue to refine the xAPI specification for semantic interoperability and will coordinate with stakeholders to deliver the implementation

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603769D8Z / *Advanced Distributed Learning*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
guidance, conformance testing tools, learning analytics, and data visualization capabilities they need to make most use of it. In FY18, this work is also expected to inform updates to DoD Instruction 1322.26's fungible technical references. Competencies and Credentialing – In FY17, this program investigated competency and credentialing management technologies, and it prototyped a web-based competency framework tool as part of the Total Learning Architecture demonstration. In FY18, this PE will continue its coordination efforts across defense and federal agencies for competency-based learning, and it will continue working with professional specifications and standards bodies in development of associated interoperability specifications to aid permeability across organizational boundaries. Personal Assistant for Learning – Adaptive learning tools promise to increase the effectiveness and efficiency of training and education, and these tools are critical parts of DoD's modern "learning ecosystem" vision. This program examines the science and technology needed to design such capabilities, using open-architecture and open-source methods. In FY17, this PE successfully tested several frameworks, including a smartphone-based system with Defense Language students and a table-based e-book capability with Special Operators. In FY18, this program plans to work with other agencies to transition some of these capabilities into operational use, coordinate with professional specifications and standards bodies to author relevant technical guidelines, and to continue development of these emerging capabilities. Interagency and Interorganizational Coordination – In FY17, this program provided distributed learning modernization support to more than 40 defense agencies (e.g., The Army Distributed Learning Program, Naval Education and Training Command, Air Education and Training Command, Marine Corps Training and Education Command, Joint Knowledge Online, Defense Acquisition University), more than 15 international partners (e.g., NATO, The Technical Cooperation Program, Partnership for Peace Consortium), and other federal agencies (e.g., National Park Service, Customs and Border Protection). In FY18, this program will continue to coordinate with these stakeholders and with relevant working groups, such as the Defense ADL Advisory Committee, to create technical alignment of distributed learning systems and find efficiencies for the government. ***FY 2019 Plans:*** Total Learning Architecture – The Total Learning Architecture will enter its third phase of development, which is expected to include additional application domains and integration with other talent management systems. Learning Data – Collaborate with operational defense training and education organizations to help them implement at-scale instances of prototype learning data interoperability specifications, learning analytics, and visualization capabilities. Ongoing efforts will also continue to inform the DoD Instruction 1322.26's fungible technical references.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603769D8Z / *Advanced Distributed Learning*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Competencies and Credentialing – Continue coordination efforts across defense and federal agencies for competency-based learning, with the associated technical guidance potentially informing DoD Instruction 1322.26's fungible technical references, once they mature. Personal Assistant for Learning – Complete development cycles of tablet-based and web-based prototypes. Continue transition of mature specification into relevant technical guidelines, and continue to investigate emerging capabilities. Interagency and Interorganizational Coordination – Continue coordination with defense, federal, and international stakeholders, and with relevant working groups, such as the Defense ADL Advisory Committee, to create technical alignment of distributed learning systems and find efficiencies for the government. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction due to the fiscal guidance adjustments.			
Accomplishments/Planned Programs Subtotals	10.384	11.211	13.564

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

F. Performance Metrics

The primary objectives of this PE are to inform distributed learning modernization efforts, to develop associated policy and guidance documents, and to coordinate across distributed learning agencies to create technical alignment of distributed learning systems and find efficiencies for the government.

MODERNIZATION: The modernization work consists of a collection of smaller technical efforts, each with project metrics that reflect their unique technical goals. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged by other defense and federal agencies, the increase in the number of interoperable training and education digital systems, the impact of these efforts on defense/federal strategic planning, and downstream reductions in training and education portfolio costs.

DOCUMENTATION: For the policy and documentation efforts, metrics include at-least annual update of published guidance, ensuring the documentation adheres to current technical/industry standards. The policy and documentation utility is also judged based upon its use, including both number of vendors adopting the policy and number of defense/federal acquisition efforts adhering to the guidance.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603769D8Z / *Advanced Distributed Learning*

COORDINATION: For the interagency and interorganizational coordination efforts, performance is first measured based upon the number of agencies, international organizations, and professional groups directly supported. Success is measured based upon the number of requirements consolidated across defense and federal stakeholders, an increase in partnering between agencies for distributed learning resource sharing, and, ultimately, in improved return on investment for distributed learning efforts.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*

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	-	13.726	15.047	15.050	-	15.050	15.154	15.285	15.449	15.741	Continuing	Continuing
781: *Software Engineering Institute (SEI)*	-	13.726	15.047	14.050	-	14.050	14.154	14.285	14.449	14.741	Continuing	Continuing
816: *Cyber Security*	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

Software is more pervasive than ever, and computer programs are growing in size and complexity. Designing, managing, and securing integrated, complex, and large-scale mission-critical systems are abilities that the DoD and the Defense Industrial Base (DIB) have not yet mastered. Reliance on software-intensive mobile and net-based products and systems has increased (e.g., Joint Tactical Radio System, USS ZUMWALT (DDG-1000), Joint Strike Fighter, F-22, and Army Modernization). As stated in the January 2017 Defense Science Board Report, “Defense Research Enterprise Assessment,” software, autonomy, and cyber are today’s core challenges. With growing global parity in software engineering, the DoD must maintain leadership to ensure a competitive advantage.

The Software Engineering Institute (SEI) Federally Funded Research and Development Center (FFRDC) was established in 1984 as an integral part of the DoD’s initiative to identify, evaluate, and transition software engineering technologies and practices. The mission of the SEI is to provide the DoD with technical leadership and innovation through research and development to advance the practice of software engineering and technology. The SEI works across government, industry, and academia to improve the state of software engineering from the technical, acquisition, and management perspectives. The SEI engages in research and development of critical software technologies and tools and collaborates with the larger software engineering research community. It facilitates rapid transition of software engineering technologies into practice and evaluates emerging software engineering technologies to determine their potential for improving software-intensive DoD systems.
Since its inception, the SEI has helped to transform the fields of software engineering and acquisition, network security, real-time systems, software architectures, and software-engineering process management.

The SEI Program Element (PE) addresses the critical need to research, develop, and rapidly transition state-of-the-art software technology, tools, development environments, and best practices to improve the engineering, management, fielding, evolution, acquisition, and sustainment of software-intensive DoD systems. The research conducted by this PE directly benefits the technical domains such as Command, Control, Communications, Computers, and Intelligence (C4I), Autonomy, Cyber, and Engineered Resilient Systems.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	14.264	15.047	15.156	-	15.156
Current President's Budget	13.726	15.047	15.050	-	15.050
Total Adjustments	-0.538	0.000	-0.106	-	-0.106
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.520	-			
• FFRDC Transfer	-0.016	-	-	-	-
• Other Program Adjustments	-0.002	-	-0.005	-	-0.005
• Economic Assumption	-	-	-0.101	-	-0.101

Change Summary Explanation

FY 2019 adjustments are reflective of higher priority DoD requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*	**Project (Number/Name)** 781 / *Software Engineering Institute (SEI)*

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
781: *Software Engineering Institute (SEI)*	-	13.726	15.047	14.050	-	14.050	14.154	14.285	14.449	14.741	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program has two main research thrusts with known military applications: 1) Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance) and 2) Information Assurance.

SEI research focuses on the most significant and pervasive software challenges within the DoD, such as the scalability and reliability of software assurance, supply chain risk management, validation of and trust in autonomous systems, human-computer and human-technology teaming and interaction, computing and communication at the tactical edge, and efficiency and performance of acquisition strategies and software development appropriate for a contested cyber environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Software Engineering Institute Advanced Technology Development in the Area of Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance)	9.104	9.802	9.750
Description: This research seeks to mature and rapidly prototype techniques to verify methods for identifying requirements, systems of systems architectures, and virtual integration of components. Furthermore, research in this area will pursue rapid prototyping and transitioning of capabilities that verify requirements for software assurance, analysis/control of unverified code and automated repair of damaged code. Software production and code analysis methods developed through this program will also improve the ability to predict how complex software systems will behave in untested environments. Increasingly, large numbers of lines of code will require a commensurate increase in sophisticated verification and validation mechanisms. ***FY 2018 Plans:*** • Integrate technologies from verification, human prediction, and human-robot understanding to enhance military-grade, scalable, and secure autonomous systems. • Reduce risk for DoD systems by integrating commercial off-the-shelf (COTS) technology, legacy, and custom software into current software architecture common control systems. • Enhance decision making by developing new algorithms and technologies that relate multiple patterns from all source data to provide quantified courses of action in tactical timeframes. • Facilitate better sustainment decisions for managing software-intensive systems. • Research, develop, and pilot quantitative software acquisition decision support tools, focused on cost-effectiveness, for DoD acquisition teams. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*	**Project (Number/Name)** 781 / *Software Engineering Institute (SEI)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Mature, deploy, and test tools that provide runtime assurance (RA) for automated complex and safety–critical mission systems. • Develop and test assurance frameworks and methodologies for Internet of Thing (IoT) devices, control nodes, and other intermediaries in DoD mission systems. • Develop and prototype full software cost models using causal learning algorithms of DoD software cost. • Develop, test, and prototype automated video summarization and detection against research and military datasets. The prototypes will use unsupervised machine learning (ML) approaches that incorporate minimal, opportunistic analyst feedback. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase in budget from FY 2018 to FY 2019 reflects additional resources required for prototype development.			
Title: Software Engineering Institute Advanced Technology Development in the Area of Information Assurance ***Description:*** Powerful machine learning algorithms can be subverted by malicious manipulation or falsification of data collected through normal channels. Algorithms must be trusted and effective in the presence of adversaries. This thrust seeks to defend against and minimize the impacts of information falsification attacks. ***FY 2018 Plans:*** • Mature tools and techniques for model-based engineering of software-reliant systems and generating assurance evidence. These tools and techniques will include support for automatic generation of secure code, automated code vulnerability discovery, and synthesis of assurance cases. ***FY 2019 Plans:*** • Develop and test augmented and virtual reality technologies for cyber mission application, training, and workforce development. • Develop and prototype dynamic, self-modification enabling software to increase the resiliency in machine learning systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease in budget from FY 2018 to FY 2019 reflects the release of resources going from development phases into test phases.	4.622	5.245	4.300
Accomplishments/Planned Programs Subtotals	13.726	15.047	14.050

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• BA 2, PE # 0602751D8Z, P278: *Software Engineering Institute Applied Research*	8.105	8.955	9.362	-	9.362	9.680	9.764	9.868	9.927	Continuing	Continuing

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*	**Project (Number/Name)** 781 / *Software Engineering Institute (SEI)*

C. Other Program Funding Summary ($ in Millions)

Line Item	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

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

- Transition of tools and practices for use in DoD programs of record to the DIB, and to a number of agencies and organizations sponsoring work.
- Number of publications in refereed journals and peer reviewed reports.
- Number of external research collaborations and interactions with the broader software engineering research community.
- Adoption of coding standards and process techniques by standards bodies, working groups, and software/systems engineering organizations

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603781D8Z / *Software Engineering Institute (SEI)*	**Project (Number/Name)** 816 / *Cyber Security*

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
816: *Cyber Security*	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

SEI research focuses on the most significant and pervasive cybersecurity challenges within the DoD, such as the scalability and reliability of software assurance, supply chain risk management, validation of and trust in autonomous systems, human-computer and human-technology teaming and interaction, computing and communication at the tactical edge, and efficiency and performance of acquisition strategies and software development appropriate for a contested cyber environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Cyber Security ***Description:*** This thrust seeks to increase the security of network-centric autonomous systems. These systems are currently developed with a focus on function rather than security, which makes them particularly vulnerable to cyber-attacks. ***FY 2019 Plans:*** In FY 2019, this program will develop technologies and techniques for integrating automated code self-repair into existing systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no notable change in the Cyber investment between FY 2018 and FY 2019. Note the Cyber effort was funded in Project P781 in FY 2018.	0.000	-	1.000
Accomplishments/Planned Programs Subtotals	0.000	-	1.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

- Transition of tools and practices for use in DoD programs of record to the DIB, and to a number of agencies and organizations sponsoring work.
- Number of publications in refereed journals and peer reviewed reports.
- Number of external research collaborations and interactions with the broader software engineering research community.
- Adoption of coding standards and process techniques by standards bodies, working groups, and software/systems engineering organizations

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*

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	327.810	77.354	69.203	69.626	-	69.626	71.393	73.945	75.131	75.744	Continuing	Continuing
826: *Quick Reaction Fund*	102.134	24.360	21.828	21.876	-	21.876	22.452	23.289	23.671	23.862	Continuing	Continuing
828: *Rapid Reaction Fund*	209.202	49.203	43.418	43.753	-	43.753	44.905	46.579	47.342	47.723	Continuing	Continuing
831: *Joint Rapid Acquisition Cell Support*	7.978	1.583	1.652	1.669	-	1.669	1.685	1.702	1.719	1.736	Continuing	Continuing
833: *Strategic Multi-Layered Assessment (SMA) Support*	8.496	2.208	2.305	2.328	-	2.328	2.351	2.375	2.399	2.423	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

The Quick Reaction Special Projects (QRSP) Program Element develops risk-reducing prototypes and conducts experiments designed to develop capabilities in anticipation of emerging adversary threats, while addressing immediate needs of the Combatant Commands (CCMD). QRSP efforts support the Department's goal to provide a hedge against technical uncertainty by leveraging commercial technologies and acting as an incubator for potentially game-changing capabilities. This Program Element also supports the Department of Defense's (DoD) strategy to address future threats in a more competitive environment with resurgence of near-peer competitors and adversaries who have studied and worked to counter U.S. technological capabilities. QRSP provides an agile mechanism to affordably counter emerging technological threats, inform the requirements process, and help maintain DoD's technical superiority, while fostering collaboration among other government agencies, DoD laboratories, academia, and the commercial sector. Funding in this Program Element enables the new Under Secretary of Defense for Research and Engineering (USD(R&E)) to anticipate and respond to emergent DoD issues and time-sensitive threats by selecting projects within the year of execution. Due to the relatively low average cost of projects, QRSP is able to explore higher-risk opportunities with potentially higher reward. Project selection is guided by Department-level strategies and priorities, such as the Chairman's Gap Assessment, USD(R&E) strategic guidance, and CCMD Integrated Priority Lists (IPLs).

The QRSP Program supports four major project codes that expedite development and transition of new capabilities to the warfighter. These project codes are: 1) Quick Reaction Fund (QRF), 2) Rapid Reaction Fund (RRF), 3) Joint Rapid Acquisition Cell (JRAC) support, and 4) Strategic Multi-Layered Assessment (SMA) Cell support. Focus areas within these project codes align to DoD science and technology priorities, including counter anti-access/area denial; counter weapons of mass destruction; target identification and tracking; intelligence, surveillance, and reconnaissance; low-cost precision engagement; counter-electronic warfare; technical risk assessments through wargaming; and, autonomous systems.

The QRF objectives are to develop prototypes in response to emergent conventional warfare needs that take advantage of breakthroughs in rapidly evolving technologies and accelerate these capabilities to the warfighter. The QRF program initiates prototyping projects during the execution year to mature technologies critically needed for the CCMDs. QRF focus areas include anti-access and area denial, broad electronic warfare, and autonomous learning systems for processing and analyzing intelligence streams.

The RRF objectives are to develop proof-of-concept prototypes to counter emerging irregular warfare threats, anticipate adversaries' exploitation of new technologies, and expedite delivery of effective, affordable, and critically needed capabilities to the warfighter. RRF initiatives support the DoD Research and Engineering Enterprise mission to develop, demonstrate, assess, and rapidly field innovative and affordable concepts and technologies that meet time-sensitive operational needs as identified by CCMDs, military Service organizations, other Defense organizations, and interagency partners. RRF leverages emerging capabilities, such as advanced algorithms and software intelligence, to enable conceptual prototyping with agile technology insertion. The program also leverages existing capabilities in our traditional industrial bases and non-traditional suppliers in the commercial sector, academia, international arenas, and small businesses.

The JRAC focus is on responding, in timeframes acceptable to the CCMDs, to Joint Urgent Operational Needs (JUONS) and Joint Emerging Operational Needs (JEONS) that are submitted by CCMDs and validated by the Joint Staff. To meet these objectives, JRAC leverages contingency and other rapid acquisition authorities.

The SMA Cell's objective is to support CCMDs, Joint Force Commanders, and other government agencies by assessing complex operational and technical challenges, which require collaborative multi-agency and multi-disciplinary approaches. With input from across the U.S. Government, academia, and the private sector, the SMA Cell develops options to Joint Staff and CCMD-generated challenging problems to inform senior leadership. Each assessment is initiated at the request of CCMD senior leadership. Priorities for SMA Cell programs are set by the Joint Staff Deputy for Operations. SMA products are typically generated within six months and directly contribute to the decision-making process of the Joint Staff and CCMD senior leadership.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	74.943	69.203	72.985	-	72.985
Current President's Budget	77.354	69.203	69.626	-	69.626
Total Adjustments	2.411	0.000	-3.359	-	-3.359
• Congressional General Reductions	-5.000	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.489	-			
• Hardware/Software (HW/SW) transfer	-	-	-2.000	-	-2.000
• FFRDC Transfer	-0.089	-	-	-	-
• Other Baseline Adjustment for DoD priorities	-0.011	-	-0.838	-	-0.838
• Economic Assumption	-	-	-0.521	-	-0.521

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*

Change Summary Explanation

The FY 2017 increase is the net of congressional adjustments and other required execution year adjustments.

In FY 2019, the baseline decrease is the net of a $2.000 million transfer out of the Hardware/Software (HW/SW) Assurance and Integrity Analysis project to Program Element 0604294D8Z (Trusted and Assured Microelectronics), and adjustments applied to fund other DoD requirements and priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

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
826: *Quick Reaction Fund*	102.134	24.360	21.828	21.876	-	21.876	22.452	23.289	23.671	23.862	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Quick Reaction Fund (QRF) provides the Services, Combatant Commands (CCMDs), and force providers opportunities to capitalize on relatively mature technologies to rapidly develop and field-test promising new conceptual prototypes that can have immediate impact on time-sensitive operational needs. QRF focuses on projects that have the potential to address conventional, disruptive, and asymmetric warfare needs. QRF initiatives typically deliver a prototype application within 12 months of being funded.

In FY 2018 and FY 2019, QRF will continue to identify and fund prototypes and technology demonstrations that respond to critical operational needs and emerging threats. Investments respond to Department, CCMD, Service, and other government organization identified threats and opportunities, including the following interest areas: counter anti-access and area denial; electromagnetic bandwidth and spectrum enhancement; persistent intelligence, surveillance, and reconnaissance; novel human identification technologies; human-machine collaborative decision making; and, counter-electronic warfare technologies.

Recent success stories and significant transitions of note include:
- Robust Automatic Transcription of Speech: This project successfully developed a speech triage capability to determine if and when there is speech in a captured radio frequency signal. Once speech has been detected, the prototype can identify speakers, languages, and keywords in real time across multiple channels. In 2017, this project transitioned to the Naval Air Systems Command Maritime Patrol and Reconnaissance Aircraft Program Office (PMA-290) for deployment and follow-on integration on Navy signals intelligence platforms.
- Robust Tactical Data Link Modernization: This project developed new Link 16 improvements for increased anti-jam communication performance. The project also designed a real-time processor that fits into existing radio circuit card slots to increase adoption of the new technology. Details of this project are classified. Robust Tactical Data Link Modernization transitioned to the Multifunctional Information Distribution System (MIDS) radio program for integration into the Link 16 baseline system.
- CyberPhantom: This project developed fully customizable cyber tools for open network exploitation. The solution leveraged best practices of the cyber workforce and expanded cyber space capabilities with a unique blend of commercial-off-the-shelf (COTS) software integrated with new customized tools. Details are classified. In January of 2017, CyberPhantom transitioned to a classified operation user.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Hammerhead ***Description:*** The Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics is responding to the need for more available courses of action (COAs) in the event of certain space systems contingencies. Initial funding in FY 2017 identified potential COAs and defined scope necessary for testing in FY 2018. Transition to the end user is expected in FY 2018. Details are classified.	1.800	-	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Hardware/Software (HW/SW) Assurance and Integrity Analysis ***Description:*** The Department of Defense (DoD) has developed a trusted systems strategy including focusing efforts on mission assurance, comprehensive protection planning, industry standards, and advancing DoD's capability to identify and mitigate HW/SW vulnerabilities through science and technology (S&T). These HW/SW Assurance projects directly support all elements in the 2014 National Defense Authorization Act (NDAA) Section 937. This program established the Joint Federated Assurance Center (JFAC) that federates hardware and software assurance expertise and capabilities throughout DoD and makes the capabilities directly available to programs. The JFAC provides tools, services, best practices, contract language, and other help to programs that detect, assess, prioritize, and mitigate mission critical vulnerabilities to malicious software attacks and supply chain exploitation vulnerabilities. The collaboration helps mitigate existing and emerging critical threats and vulnerabilities in both SW and HW and yields secure architecture and design patterns available to all DoD programs. Trusted and Assured Microelectronics Program Elements 0604294D8Z BA4 and 0605294D8Z BA5 demonstrate these capabilities and augment the hardware assurance capabilities of the JFAC. ***FY 2018 Plans:*** Continue to maintain infrastructure services and staff for the JFAC Coordination Center (CC), enabling the centralized assurance repository, assurance contract language, metrics, the JFAC ticketing system for software assurance (SwA) tool license distribution, help-desk, and hard problem analysis. Incorporate Defense Advanced Research Projects Agency (DARPA) and Defense Acquisition University (DAU) products into the JFAC website. Develop and publish a SwA users and program manager's guidebook to aid implementation of SwA practices in DoD programs. Expand access to the existing assessment knowledge base to programs throughout the software development lifecycle. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This project will transition to Program Element 0604294D8Z Trusted and Assured Microelectronics in FY 2019.	4.000	2.000	-
Title: CyberPhantom Phase II ***Description:*** CyberPhantom focused on the development of fully customizable cyber tools for open network exploitation. The solution leveraged best practices of the U.S. Government's cyber workforce and expanded the capability of the DoD to operate in cyber space with a unique blend of commercial-off-the-shelf (COTS) software integrated with new customized tools. Phase II of this effort provided a scalable architecture for capability deployment, command and control, and operational analysis. CyberPhantom Phase II built on the previously deployed capability sets and transitioned to U.S. Cyber Command. Further details of this project are classified.	1.400	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Isosceles ***Description:*** Isosceles developed a classified high fidelity systems test-bed that emulates real world strategic systems. Isosceles replaces current dissimilar surrogates for testing, which vary in performance and increase uncertainty and risk for tested systems. With Isosceles, capability developers reduce cost and increase confidence that employed systems will work as expected. Isosceles was demonstrated through a systems effectiveness test in December of 2017 and transitioned to a program of record currently supporting the Services. Further details of this project are classified.	1.660	-	-
Title: XTreme Limits ***Description:*** XTreme Limits developed a capability to support 24x7, worldwide relay of command and control messages to a fielded user device (providing a “paging” like capability) and user-to-ops data return. The XTreme Limits capability supports a number of military units and other government organizations conducting high-priority mission operations. This project also provided sensor data relay for designated sensor systems. XTreme Limits paging architecture will be tested in Spring 2018 before transitioning to a classified mission partner. Further details of this project are classified.	2.800	-	-
Title: Talon Archer ***Description:*** Talon Archer developed and deployed a set of sensors demonstrating an approach to meeting a North American Aerospace Defense Command/U.S. Northern Command (NORAD/USNORTHCOM) need for long-range sensing of strategic assets. The sensors successfully provided alerts and actionable information to the Department of Defense (DoD) and partners. Success of the sensors led to adoption at four additional locations. Further details of this project are classified.	1.260	-	-
Title: Blockdata ***Description:*** Blockdata conducted an assessment of various blockchain technologies to support data integrity for distributed sensors. Blockchain technologies serve as the basis for the increasingly popular digital currency systems such as Bitcoin and Ether. The features of blockchain’s underlying technology can be used to ensure data integrity for sensors and their processed data sets. The Blockdata project assessed different blockchain technologies being developed in the commercial sector, and explored applicability, performance, and adaptability for joint warfighter applications. The project identified initial application areas and transitioned to a classified DoD agency.	1.600	-	-
Title: Sidecast ***Description:*** Sidecast focused on the development and deployment of fully customizable cyber tools for open network exploitation or computer network exploitation (CNE) for a fraction of the cost of existing programs. The solution leverages best practices of the U.S. Government cyber workforce and expands the capability of the DoD to operate in cyber space with	2.500	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
government-off-the-shelf software tools. Sidecast is designed to enhance the Combatant Commands' (CCMD) capability to operate and exploit cyber information in near real-time. The project enables the CCMDs' ability to conduct advanced open network exploitation or CNE within cyber space to support emerging mission requirements. The effort developed and delivered two customer defined operational tools to a classified user. The Sidecast capability transitioned to multiple CCMDs and agencies.			
Title: Patton ***Description:*** This project enables greater visibility into threat indications and warnings (I&W) through the integration of existing data sources and advanced data science techniques. Patton developed enhanced I&W visualization tools for the warfighter, addressing shortfalls in the ability to provide accurate and timely I&W to Combatant Commands (CCMD). Patton uses a holistic approach to identify critical threat precursors as highlighted by warfighters. In addition, a team of analysts developed a baseline of data feeds that integrated with a set of enhanced visualization tools to help communicate I&W. As a result, operators have the information required to analyze adversary threat behaviors. In FY 2017, the project developed, demonstrated, and transitioned the visualization tools to CCMD customers.	1.840	-	-
Title: Dead Center ***Description:*** Dead Center developed and demonstrated advanced, highly tailorable algorithms to meet critical warfighter mission needs in multiple domains, culminating in a user demonstration of the advanced algorithms designed to enhance warfighter effectiveness. The project integrated these algorithms to demonstrate a flexible, multi-platform functionality in a low size, weight, and power (SWaP) form factor to meet specific, highly tailored mission critical needs. Project residuals (prototypes and documentation) transitioned to classified DoD partner.	3.000	-	-
Title: Vintage Racer ***Description:*** Vintage Racer matured an advanced capability to prosecute targets of interest. This project validated the aerodynamic design with wind tunnel testing. Vintage Racer also developed and integrated a guidance subsystem for targeted kinetic effects. Following subsystem integration, FY 2017 funding supports a flight demonstration in FY 2018. The project will transition documentation and prototype technologies to the U.S. Army for any additional development and follow-on acquisition activities.	2.500	-	-
Title: Anti-Access/Area Denial Focus Area ***Description:*** This Quick Reaction Fund (QRF) focus area will support projects to develop capabilities and countermeasures for emerging needs to monitor and, as needed, gain access to geographical areas that have been strategically denied by adversarial forces and technologies. Potential capabilities could include sensors; position, navigation, and timing systems; autonomous	0.000	4.882	5.556

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
platforms; and other technologies that extend battlespace awareness and force projection. This project seeks to leverage existing capabilities and ensure QRF efforts are not duplicative with other work within the DoD or with outside agencies. ***FY 2018 Plans:*** Anti-access/area denial investment decisions during the budget year will respond to priorities to address increasing capabilities of near-peer adversaries as identified by the Department, Combatant Commands (CCMD), Services, and other government organizations. Through coordination with the DoD, Federally Funded Research and Development Centers (FFRDCs), other government agencies, industry, and academia, this focus area will help identify critical areas to address the dual challenges of getting into theater (the anti-access challenge) and operating under guided munitions threat (the area denial problem). QRF anticipates funding two to three prototypes in FY 2018. ***FY 2019 Plans:*** In FY 2019, QRF will continue efforts to identify and invest in capabilities that address anti-access/area denial challenges. These investments will be conducted to support and coordinate with the DoD, CCMDs, Services, and other government organizations. QRF anticipates funding three to four prototypes in FY 2018. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Counter Emerging Electronic Warfare (EW) Technologies Focus Area ***Description:*** Operating in complex EW environments is critical to mission success. This focus area provides the agility to select projects in the year of execution to mature conceptual prototype countermeasures against electronic warfare (EW) components and systems. These countermeasures protect forces and help achieve electromagnetic spectrum agility. The QRSP program will ensure QRF efforts are not duplicative with other counter-electronic warfare efforts and will seek to leverage related efforts. ***FY 2018 Plans:*** Investment decisions in counter-electronic warfare technologies during the budget year will respond to Department, CCMD, Service, and other government organization priorities as new opportunities and new threats emerge. Planned investments will help local communication and coordination to increase weapon systems' and forces' effectiveness in contested environments. There will be coordination with organizations throughout the DoD, FFRDCs, other government agencies, industry, and academia to help identify critical areas to counter emerging electronic warfare threats. QRF anticipates funding three to four projects in FY 2018. ***FY 2019 Plans:***	0.000	5.297	5.904

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
In FY 2019, QRF will continue efforts to identify and invest in counter-electronic warfare technologies that respond to DoD, CCMD, Service, and other government organization priorities as new threats emerge or new opportunities are presented. QRF anticipates funding three to four projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Advance Indications and Warning through Human-Machine Collaborative Decision Making Focus Area ***Description:*** This focus area for FY 2018 and FY 2019, in anticipation of emerging needs, will develop and advance rapidly deployable, conceptual prototype technologies that focus on improving the indications and warning (I&W) for a variety of mission areas to include weapons of mass destruction and theater ballistic missiles. Through the use of intelligent learning systems and human-machine collaborative decision making, I&W can improve response time and open additional options to counter emerging threats. Projects may include techniques and methodologies that improve detection sensitivities, data-to-decision tools, and global situational awareness. The project will seek to leverage related efforts. ***FY 2018 Plans:*** Investment decisions in human-machine collaborative decision making efforts during the budget year will respond to DoD, CCMD, Service, and other government organization priorities. To help identify areas critical to human-machine collaborative decision making, the project will leverage research and coordination with organizations throughout the DoD, FFRDCs, other government agencies, industry, and academia. QRF anticipates funding two to three projects in FY 2018. ***FY 2019 Plans:*** In FY 2019, QRF will continue efforts to identify and invest in human-machine collaborative decision making technologies that respond to DoD, CCMD, Service, and other government organization priorities as new threats emerge or new opportunities are presented. QRF anticipates funding two to three projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.	0.000	3.971	4.336
Title: Persistent Intelligence, Surveillance, and Reconnaissance (ISR) Focus Area ***Description:*** This focus area helps address emerging needs for persistent ISR capabilities to improve ground, air, sea, and space situational awareness. Projects will address needs identified in 2018 and 2019 through development of prototypes that explore	0.000	4.178	4.540

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
new or improved methods for surveillance sensors to persistently operate within denied areas. This focus area also explores more effective and agile ISR architectures for rapidly processing, exploiting, and disseminating intelligence. QRF will leverage existing efforts and ensure projects are not duplicative with ongoing persistent ISR work within the DoD or with outside agencies. ***FY 2018 Plans:*** Persistent ISR investment decisions during the budget year will respond to Department, CCMD, Service, and other government organization priorities. Projects will be considered as new threats emerge or new opportunities are presented. Research and coordination with organizations throughout the government, industry, and academia will help identify areas critical to developing future ISR payloads. QRF anticipates funding two to three projects in FY 2018. ***FY 2019 Plans:*** In FY 2019, QRF will continue efforts to identify and invest in persistent ISR technologies that respond to DoD, CCMD, Service, and other government organization priorities as new threats emerge or new opportunities are presented. QRF anticipates funding three to four projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: High-throughput Deoxyribonucleic Acid (DNA) Sequencing (HTS) Technology Focus Area ***Description:*** The High-throughput DNA Sequencing (HTS) Technology Focus Area will leverage technological advances in gene sequencing and bioinformatics to fundamentally change the way DNA is used to support military operations. These projects will employ current hardware coupled with custom chemistries, data analysis algorithms, databases, and information transmission pipelines to enable more comprehensive analysis of trace, degraded, and mixed DNA samples. This comprehensive data analysis allows for correlating individual activities and histories; the ability to determine biogeographical ancestry; increasing confidence in assigning extended kinship identifications; and, greater accuracy in predicting phenotypic attributes such as facial characteristics, eye colors, or skin tones and variations. This focus area also includes support for HTS databases that are designed to ingest large DNA data flows efficiently, use processing power for searching and analyzing big data, and employ big data analytics to make predictive assessments that would otherwise go unnoticed. This focus area will encourage collaboration on biometrics and forensics projects within the DoD, and with interagency, industry, academia, and international partners where applicable. This collaboration will help maximize shared investment and prevent redundant research. Deliverables are shared throughout the biometrics and forensics communities. ***FY 2018 Plans:***	0.000	1.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The HTS focus area will leverage its previous work to identify promising lines of HTS research that are feasible, cost effective, and meet the specific requirements of the end user. Based on the outcomes of FY 2017, additional investments are expected in chemistry optimization, statistical refinement, and results interpretation. Additionally, this project will include work in the analysis of highly degraded samples with smaller quantities of human DNA to support the familial matching performed at the Armed Forces DNA Identification Laboratory as part of the Personnel Accounting mission to identify and return the remains of missing personnel to their families. As more research becomes available to the life science community, the HTS program will work to identify new avenues of exploration. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Projects under this focus area are expected to be completed in FY 2018.			
Title: Face Identification at a Distance Focus Area ***Description:*** The ability to identify persons of interest from safe, concealed, and long distances is an emerging need across the Joint Force. Face identification at a distance creates challenges that can only be addressed through improvements in technology including optics, video processing, and facial recognition algorithms. Investments will address challenges associated with image resolution, stabilization, and atmospheric turbulence, as well as other factors associated with collecting images from non-cooperative individuals. Associated technologies include rapid matching algorithms, storage of large facial databases, and secure dissemination within the DoD and our partners. This project will leverage existing efforts and ensure projects are not duplicative with ongoing facial identification work within the DoD or with outside agencies. ***FY 2019 Plans:*** In FY 2019, QRF will initiate efforts for face identification at a distance that respond to DoD, CCMD, Service, and other government organization priorities as new threats emerge or new opportunities are presented. QRF anticipates funding three to four projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Face Identification at a Distance is a new focus area for 2019.	-	-	1.540
Accomplishments/Planned Programs Subtotals	24.360	21.828	21.876

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 826 / *Quick Reaction Fund*

E. Performance Metrics

In FY 2019, performance metrics applicable to the Quick Reaction Fund (QRF) include the DoD Strategic Performance goal to transition 40 percent of completing demonstration programs per year. Each QRF project typically has a period of performance of 12 months. All QRF projects are monitored for schedule deviation, transition outcome, and deliverables such as test reports, components, and equipment. For projects that were completed in FY 2017, the QRF achieved a transition rate of approximately 100 percent.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 828 / *Rapid Reaction Fund*

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
828: *Rapid Reaction Fund*	209.202	49.203	43.418	43.753	-	43.753	44.905	46.579	47.342	47.723	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Rapid Reaction Fund (RRF) project accelerates the development and transition of high-potential science and technology (S&T) projects through operationally useful conceptual prototypes. It achieves this by anticipating adversaries' exploitation of technology, including available and emerging commercial capabilities, and rapidly responding to new threats and opportunities. Needs are identified and prototype projects are funded within the year of execution to demonstrate the feasibility of new technologies, enable integration into larger systems, and increase ‘speed to market’ by providing cost effective capabilities faster than typical acquisition cycles.

In prior years, RRF supported the development of alternate power sources for sensors and systems; provided low-cost capabilities for small-footprint operations; expanded human, social, and cultural knowledge relevant to military decision making; increased small unit situational awareness; advanced the interface between law enforcement and military operations; developed advanced biometrics and forensics capabilities; performed strategic multi-layer assessments; and, established a prototyping through non-traditional pathways outreach effort that facilitates better interactions with small, non-traditional companies developing innovative technologies.

In FY 2018 and FY 2019, RRF will continue to provide a hedge against technology risk by identifying and developing near-term capabilities to support irregular warfare operations. RRF projects support goals from the new Under Secretary of Defense (Research and Engineering). The RRF’s current focus areas include: open source data analysis; autonomous systems and behaviors; urban characterization; prototypes for intelligence, surveillance, and reconnaissance; additive manufacturing to rapidly field prototypes; maritime technologies; and, novel applications of repurposed commercial-off-the-shelf (COTS) and government-off-the-shelf (GOTS) technologies. Typical RRF projects address these focus areas through a conceptual prototype within 6 to 18 months and for less than $1.000 million.

Recent success stories and significant transitions of note include:
• Advanced File Carver: This project developed a completely new tool that allows the rapid extraction and recovery of files from large data stores such as hard drives. The Advanced File Carver significantly increased the functionality available to users over comparable GOTS/COTS competitors while simultaneously increasing performance speed ten-fold. Additionally, this tool provides capabilities previously unavailable, including the reconstruction of partially overwritten files, and the recovery of digital images whose headers were deleted. As a GOTS solution, the Department of Defense (DoD) has made this technology available across the Department and to over 15 federal agencies.
• Ingres Tactical WiFi: The airborne Ingres system uses active WiFi signals and advanced processing algorithms to provide an accurate geolocation of target devices in dense, electromagnetically congested, urban environments. Ingres can identify WiFi transmitters, such as a target's phone or laptop, with better than ten meter accuracy from standoff distances. Ingres is transitioning to the U.S. Army Special Operations Command to perform evaluations in operationally relevant environments.
• Aluminum Start System: This project developed an electric plasma start system for aluminum combustors to replace the standard hydrogen-oxygen pilot-flame ignition system. Aluminum combustors are an effective alternative to fossil fuel engines that can use sea water instead of air for oxidizer; however, current systems require pressurized hydrogen and oxygen to initiate combustion. The prototype microwave-powered steam-plasma torch eliminates hydrogen-oxygen start systems and their associated risk. This effort transitioned to the U.S. Navy for follow-on development and integration into the aluminum combustion power system for large displacement unmanned underwater vehicles.

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• Bloom: Responding to an emerging operational need, Project Bloom developed a moored buoy capable of long duration surface measurement operations. The system provides a platform for radio frequency (RF), magnetic, optical, radiological, and chemical sensing on a standardized and easy to deploy buoy. The Bloom buoy includes an internal winch capable of submerging it for "sleep" periods and to avoid approaching craft. The operational prototype was deployed to the U.S. Central Command area of responsibility and transitioned.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Low Cost Innovative Projects (Projects less than one million dollars each) ***Description:*** Typical Rapid Reaction Fund (RRF) projects are completed with a single year of funding and at a cost less than $1.000 million to deliver conceptual prototypes for evaluation or assessment by warfighters and interagency users. In FY 2017, RRF selected, executed, and transitioned multiple low cost projects: • Vital Infrared Sensor Technology Acceleration (VISTA) Focal Plane Array (FPA): This project integrated a novel FPA sensor with a cryogenic cooler and electronics to provide significant performance improvements in detection ability, while also reducing size, weight, and power demands. This capability transitioned to the U.S. Army. • Soldier Borne Sensor - Autonomy in Complex Environments (SBS-ACE): The project developed autonomy algorithms for extremely small Unmanned Aerial Vehicles. The technology transitioned to the Army's SBS program of record. • Eminent Shroud: This project explored combining targeted electronic warfare (EW) effects to increase impact on adversaries without affecting U.S. and partner forces. This capability transitioned to the U.S. Air Force and U.S. Navy. • Extending Communication beyond LOS: This project integrated an unmanned parafoil system with an unmanned surface vessel to extend digital communications and sensor connectivity beyond current line-of-site limitations. This capability transitioned to the U.S. Navy. • Denali: This project used non-traditional methods of adaptive filtering to mitigate the effects of electro-magnetic interference (EMI) on military satellite communications. Adaptive signal processing enabled the use of otherwise unusable or degraded channels, thereby increasing satellite effective capacity. Denali transitioned to the Mobile User Objective System (MUOS) program of record. • Prototype Dynamic Beamforming Elements (PDBE): PDBE developed an advanced communications technology capable of being deployed on multiple platforms. This technology transitioned to the U.S. Air Force and U.S. Navy. • Tactical Arterial Compression System Development: This project developed a personal, wearable solution to control difficult to treat junctional and extremity bleeding. The capability transitioned to Naval Medical Research Unit-San Antonio for further assessment before an operational evaluation by elements from the U.S. Army Rangers and the Air National Guard. • Black Ink: The project developed a classified submarine warfare enabling technology. The technology transitioned to the U.S. Navy for implementation in submarine sensor systems. • Enhanced Bugeyes: This project enhanced the Bugeyes 360-degree filming and immersive training kit with customized software to support team participation in 360-degree video playback. Enhanced Bugeyes enables oversight by an instructor for fully	29.453	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
immersive, classroom training of complex environments and dangerous missions. The capability transitioned to Expeditionary Warfare Training Group Pacific. • Optical System Protection: This project developed a prototype optical system that uses a custom-designed phase mask to protect imaging sensors from damage by high intensity lasers. A field unit was built and successfully tested to demonstrate the optical system’s capabilities at visible wavelengths. This project transitioned to the Dahlgren Naval Surface Warfare Center High Energy Lasers department. • Passive Foliage Penetration (FOPEN): Passive FOPEN developed a capability to image targets under foliage using common passive sensors on airborne platforms. After a successful operational demonstration, the real-time hardware and software was integrated and deployed as an operational prototype in the U.S. Southern Command area of responsibility. • Unmanned Aerial Vehicle (UAV) Payload Dispenser: This project enhanced the multi-purpose small UAV “Quick Strike” system to address Joint Special Operations Command requirements for delivery of specialized payloads from a small UAV to remote or otherwise difficult to reach environments. The capability was provided as an operational prototype to U.S. Special Operations Command. • Eminent Tower: This project leveraged advances in mobile cognitive radar frequency (RF) technologies to port existing electronic warfare capabilities from large fixed-site facilities to mobile systems. Eminent Tower transitioned to the Joint Counter Radio-Controlled Improvised Explosive Device (IED) Electronic Warfare (JCREW) program. • Automation for Strategic Target Deployability: This project enables the automated and timely mapping of key infrastructure at scale using commercial imagery. Further details of this project are classified. • Joint Advanced Video Activity Analytics (AVAA) Workflows: This project developed a capability for the rapid exploitation of video imagery, enabling analysts to rapidly assemble automated analysis workflows using custom computer vision algorithms as building blocks. Developed building blocks include automated video enhancement (stabilization, de-hazing, etc.), scene classification, automatic object identification, and object and anomaly tracking. The capability deployed as an operational prototype in the U.S. Africa Command area of responsibility. • Directed Laser Focus: The project applied optical phase conjugation via digital holography to tailor a laser beam’s spatial energy distribution and optimize overall system performance when transmitting long distances through the atmosphere. This capability was provided as an operational prototype to U.S. Special Operations Command. • Swift Vision: The project developed a computer-vision-enabled unmanned aerial system that supports a classified maritime mission. The capability deployed as an operational prototype in the U.S. Pacific Command area of responsibility. • Silent Saber: This project developed a laser system used by explosive ordnance disposal (EOD) technicians for the neutralization of improvised explosive devices (IEDs) and unexploded ordnance (UXO) from greater range. The capability transitioned to Joint Service Explosive Ordnance Disposal (JSEOD). • Scalable Effects Anti-Personnel (SEAP): This project developed expeditionary kinetic payloads capable of engaging enemy combatants while also minimizing collateral damage. The capability transitioned to Naval Special Warfare Command.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Solid State Pulsed X-Ray Generator: This effort developed a compact solid-state pulsed X-ray generator prototype for use by explosive ordnance disposal (EOD). The prototype images the interior of IEDs while significantly improving accuracy and speed. The prototype transitioned to Joint Service Explosive Ordnance Disposal (JSEOD). • Machete LADAR Enhanced Onboard Processing: This project developed improved real-time onboard processing algorithms for an airborne LADAR system, reducing the time necessary to generate actionable data products. The capability deployed as an operational prototype in the U.S. Southern Command area of responsibility. • Gradient Virgo: Gradient Virgo integrated precision measuring matrix (PMM) software into the V-Space Tactical voice recognition system. The PMM integration allows for improved speaker correlation and recognition with a decreased error rate. This capability was provided as an operational prototype to U.S. Special Operations Command. • Multi-Intelligence Tactical Edge Analytics: This effort developed optimized methods for partial processing of intelligence data at the collection source. This reduces required bandwidth for transmitting intelligence and results in actionable data products faster. The resulting capability transitioned to a classified DoD operation. • Universal Language TRAnslator (ULTRA): This project developed an Android application that enables the remote warfighter to translate uncommon languages without the need for internet connectivity. The application included an expanded lexicon of military-specific terms that are not normally contained in commercial translation tools. The prototype also includes a toolset that allows users to build additional language modules, which can be downloaded onto an Android phone to be used remotely. This technology deployed as an operational prototype in the U.S. Africa Command area of responsibility. • Midwave Infrared (MWIR) Halo Beacon: This project developed a rugged, waterproof beacon for signaling friendly forces while preventing detection from overhead surveillance. The resulting prototype transitioned to Naval Special Warfare Command. • Flexible Buoyant Body Armor: The project developed a flexible and buoyant body armor system. Within this effort multiple experiments were conducted to achieve National Institute of Justice ballistic protection levels three and four. This capability transitioned to the Air Force Research Laboratory. • High Accuracy Video Object Classification (HAVOC): HAVOC developed an inexpensive, customizable, and highly accurate real-time automatic target recognition (ATR) system for rapid exploitation of full motion video (FMV). This technology transitioned to multiple Special Operations Forces (SOF) components. • Hive Final Mile: This project demonstrated a revolutionary enterprise resource planning tool for distributed logistics in a decentralized battle space. Hive provides warfighters with faster and more accurate resupply by enabling individual warfighters to request supplies through an Android interface. The system aggregates and routes requests, prioritizes shipments, and tracks delivery of supplies to enable automated distribution logistics. Hive transitioned to the U.S. Marine Corps and separately for evaluation in the U.S. European Command area of responsibility. • SOF Combat Diver Communications: The project developed and demonstrated an underwater non-detectable communications system for integration into multiple platforms. This technology transitioned to the Naval Special Warfare Command.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Orthos: The project developed customizable, concealable field-sets that communicate position, brief messages, or code words to multiple, multi-purpose cross-connected receiver platforms in challenging threat or degraded communications environments. Orthos transitioned to Special Operations Forces (SOF) warfighters from multiple components. • Jungle and Urban Non-Global Positioning System Orientation (JUNO): The project incorporated bionic power leg brace sensors into dead reckoning algorithms developed for navigation in Global Positioning System denied and degraded environments. The prototype transitioned to the Space and Naval Warfare (SPAWAR) Systems Center Pacific (SSC Pacific) for integration into the Pacific's Battlefield Objective Navigation Display (BOND) application for dismounted infantry. • Computational Reconfigurable Image Spectrometer (CRISP): CRISP developed a small form factor, enhanced-sensitivity hyperspectral imagery (HSI) sensor capable of operation without active cooling. The capability was provided as an operational prototype to U.S. Special Operations Command. • Advanced Persistent Malware Threat Intrusion Projection Tool: This project developed a prototype computer network intrusion protection system (IPS) to detect, quarantine, and report attacks on DoD and defense industrial base computer networks. This capability transitioned to a DoD Crime Center. • Shortstop: This project developed enhanced network security capabilities and automated security workflows. Shortstop allows operators to respond to attacks in relevant timeframes. The technology deployed as an operational prototype in the U.S. Pacific Command area of responsibility. • Whistler: This project developed an ability to detect unmanned aerial systems (UAS) and alert dismounted soldiers of their presence. The technology was provided as an operational prototype to U.S. Special Operations Command. • Dancer: This project enabled joint warfighters to send and receive encrypted messages with a low probability of being detected or intercepted. The capability was provided as an operational prototype to U.S. Special Operations Command. • Spatially Selective Electronic Attack: This project developed a capability to target electronic warfare (EW) effects to a small geographical region, and reduce impact on neutral or partner forces. This capability transitioned to a classified customer. • Distributed Detection and Tracking: This project developed technology to identify and track moving people or vehicles across several disparate overhead video feeds collected by a distributed "swarm" of UAVs. The capability was provided as an operational prototype to U.S. Special Operations Command. • Tactical Application Security: This effort enhanced current network security capabilities by providing a method to virtually contain and dynamically encrypt computer processes. This technology transitioned to the U.S. Army. • Millimeter Wave (MMW) Sensing for Autonomy Phase II: This project developed and evaluated a commercial automotive radar technology as a low-cost sensor for autonomous military applications. The technology transitioned to the Air Force Research Laboratory for further development. • Identity Operations (ID-OPS) for Open-source Intelligence (OSINT): This effort developed the techniques and software needed to discover potential threats by connecting individuals to other persons, places, events, or materials, and analyzing their patterns of life. The capability was provided as an operational prototype to U.S. Special Operations Command and other government partners.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
• Face Acquisition Recognition of Identities (FAR-ID): This project provided long range surveillance and near real-time identification capabilities to the warfighter by using advanced optics capable of detecting and matching faces from distances exceeding 500 meters. This technology transitioned to Program Manager DoD Biometrics. • Single Sweep: This project developed novel algorithms to process raw radar data differently in order to identify unmanned aerial vehicles in real time. This technology transitioned to the Navy's Fleet Forces Command. • Model Enhanced Analysis, Design, & Execution (MEADE) Predictive Control System: MEADE successfully prototyped a software system and concept of operations that improves DoD's ability to conduct analysis and planning at the operational level. The effort was provided as an operational prototype to the Joint Special Operations Command and three Theater Special Operations Commands. • Lite Saber: This project created a payload for unmanned aerial systems that extended the range and data transfer rate of ground force communications. This capability was provided as an operational prototype to U.S. Special Operations Command for a military utility assessment. • Autonomous Littoral Connector (ALC): This project developed the capability to autonomously move cargo from a maritime prepositioned force to the beach and to return without human intervention. The capability transitioned to Office of Naval Research for incorporation in the Autonomous Continuous Trail Unmanned Vehicle.			
Title: Wide-area Infrared System for 360-degree Persistent Surveillance - Spiral-2 (WISP-2) ***Description:*** The WISP-2 system uses passive infrared imagery to detect and track moving air and ground targets within the sensor's range and field-of-view. WISP-2 was developed for Counter-Unmanned Aerial System (CUAS), but has broad applicability for use against other air and ground targets of interest. WISP-2 technology is enabled by infrared digital-pixel focal plane array (DFPA) and real-time processing algorithms and software. The advanced processing algorithms automatically adapt to the scene and detect the presence of moving objects in the surroundings. WISP 2.0 was successfully demonstrated and operationally fielded in the U.S. Central Command's area of responsibility as a solution to a Joint Urgent Operational Need.	1.500	-	-
Title: Common Unmanned Aerial Vehicle System Simulation (CUAVSS) ***Description:*** The CUAVSS project developed and demonstrated a simulation environment for unmanned aerial vehicles (UAV) and sensor combinations, allowing operators to plan missions based on simulated performance in operationally realistic scenarios. The simulation environment can be adapted to assess UAV performance throughout the UAV lifecycle including research and development, air vehicle and payload configuration, mission review, and failure analysis and mitigation. Subsequent to an FY 2018 demonstration, CUAVSS will transition to users within Naval Systems Command and U.S. Special Operations Command. This technology area is a congressional interest item and in FY 2017 additional resources were provided above the President's budget request, exceeding typical limits for RRF funded projects.	3.650	-	-
Title: Ultra-Lightweight, High-Efficiency Solar Panels for HALE Aircraft	5.000	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Description: This project developed lightweight, efficient, and flexible solar panel sheets for integration onto High Altitude, Long Endurance (HALE) aircraft. The high specific power of these advanced solar cells is 25 percent better than other commercial solar cells, and will enable unmanned aerial systems (UAS) to conduct long endurance missions with increased propulsion and payload power requirements. The ultra-lightweight, high-efficiency solar panels will transition to users within U.S. Central Command and U.S. Pacific Command. This technology area is a congressional interest item and in FY 2017 additional resources were provided above the President's budget request, exceeding typical limits for RRF funded projects.			
Title: Strategic Multi-Layered Assessment (SMA) Cell ***Description:*** The SMA Cell provides planning support to Combatant Commands (CCMDs) and U.S. Government agencies; and, provides actionable assessments of complex operational and technical challenges to help maintain our competitive advantage in an increasingly complex global environment. The SMA reach-back cell was established by the Joint Staff Deputy Director for Global Operations (DDGO) at the request of the Commander, U.S. Central Command (USCENTCOM). SMA efforts leverage multi-agency, multi-disciplinary approaches to address requirements that are not within the customer organization's core competency. SMA assessments are framed during the year of execution and are in response to specific tasking from senior leadership in the CCMDs. The SMA Cell identifies options from across the U.S. Government, academia, and the private sector. SMA efforts are facilitated by the Joint Chiefs of Staff/J-3 Operations and are executed by the Office of the Under Secretary of Defense, Research and Engineering. The SMA Cell provides USCENTCOM with population-based and regional expertise in support of ongoing operations in the Iraq/Syria region. ***FY 2018 Plans:*** The SMA Cell will continue to work with USCENTCOM via the reach back cell to support ongoing operations in Iraq and Syria by responding to queries from senior leaders. The SMA cell was asked by USCENTCOM Commander to continue to develop the reach back concept to provide a short term tool to assist his staff in understanding actor relationships and conducting if/then analyses. The SMA Cell will also continue to actively work with the CCMDs and the Joint Staff to identify challenging problems that are not within the traditional areas of DoD expertise. These problems will be in direct support of CCMD senior leadership and may include areas such as: counter terrorism, transnational criminal organizations, counter weapons of mass destruction (state and non-state), counter global or regional social and cultural assessments, regional stability assessments, and individual state or national level deterrence studies. ***FY 2019 Plans:*** The SMA Cell will continue to actively work with the CCMDs and the Joint Staff to identify challenging problems that are not within the traditional areas of DoD expertise. These problems will be in direct support of CCMD senior leadership. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	2.100	2.100	2.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Title: Faster Short Tandem Repeat (FaSTR) Human Deoxyribonucleic Acid (DNA) Profiling System ***Description:*** Previous rapid DNA analysis systems have relied on pneumatics and mechanical valves for microfluidic movement. Current systems are comprised of bulky hardware and DNA analysis times greater than 60 minutes. The FaSTR DNA instrument exploits centrifugally-driven microfluidics to eliminate mechanical valves and pressure-driven flow, and allows commercial-off-the-shelf electronics to facilitate sample preparation, polymerase chain reaction, and assessment. This paradigm shift to microfluidic technology radically reduces the form factor, analysis time, and cost of the system. The FaSTR project will produce the first truly portable, rapid DNA analysis instrument capable of generating DNA profiles from “sample in” to “answer out” in less than 30 minutes and provide a match probability of 1 in 55 billion people. ***FY 2018 Plans:*** Leveraging FY 2017 accomplishments, the project will deliver three prototypes and 75 consumables for operational testing in theater. The prototypes will weigh less than ten pounds and can compare a sample to a nine loci DNA profile in less than 30 minutes. Test results, technical and training materials, and initial low rate production manufacturing technical specifications will be included in the deliverables. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This project will be completed in FY 2018.	1.000	1.000	-
Title: Biometrics and Forensics Science and Technology for Identity Dominance ***Description:*** Biometrics and Forensics Science and Technology projects field prototypes to address emerging technology gaps that limit our ability to quickly and accurately identify anonymous individuals who threaten our physical and virtual assets. The overall goal of these projects is to reduce future operational risk to warfighters. New technologies demonstrated through this program will allow warfighters to identify bad actors or counter adversaries’ attempts to mitigate our technologies. These projects leverage techniques such as conceptual prototyping, increased use of small businesses, and increased competition between vendors. Biometrics and forensics projects will mature emerging technologies that support identity operations and forensic capabilities required by commanders and warfighters in ongoing and future military activities. These efforts encourage collaboration on biometrics and forensics projects within the DoD, and with interagency, industry, academia, and international partners where applicable. This model will help maximize collaborative investment and prevent redundant research. Deliverables are shared throughout the biometrics and forensics communities. ***FY 2018 Plans:*** The biometrics and forensics science and technology portfolio will continue to mitigate gaps identified by commanders and operational users and improve capabilities in the areas of biometrics and forensics. The portfolio will continue work on projects	3.500	3.450	3.400

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
scheduled for FY 2018 delivery that include the Enhanced Access Control for Husbanding Operations using Biometrics project, a web-based enrollment application to enable private foreign agencies to submit personnel biometric and biographic data directly to DoD law enforcement agencies for vetting; the Advanced Persistent Threats Intrusion Protection System, a computer network intrusion protection system prototype to prevent nation states from gaining access to DoD, Joint Force, and defense industrial base information networks; and, the DoD Biometrics System Interoperability Lab (SIL) and Long Range Facial Identification Database, a repository of face imagery collected at various standoff distances and operational conditions with a related biometric SIL capability to conduct testing and assess the performance of face matching algorithms. Additional projects for biometrics and forensics portfolios will be selected after coordination throughout DoD and across other U.S. Government departments and agencies to maximize collaborative investment and prevent unnecessary redundant research. ***FY 2019 Plans:*** RRF investment decisions for the biometric and forensic portfolio will be based on emerging threats and requirements identified by the CCMDs, institutional forensic laboratories, and other biometric and forensic stakeholders. The portfolio will continue work on projects scheduled for FY 2019 delivery including The Autonomously Sharing Biometric Enabled Watchlist (BEWL), a capability that provides near real-time BEWL information to DoD Components. New projects under consideration will be thoroughly coordinated across the biometric and forensic enterprises to minimize duplication, maximize cooperative funding, and identify the most promising projects with the strongest path for transitioning the technology. RRF anticipates supporting six to eight projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Title: Prototyping Through Non-Traditional Pathways ***Description:*** Prototyping Through Non-Traditional Pathways leverages technology and emerging products developed by small, innovative businesses in the commercial sector. Ideas from non-traditional emerging technology companies are matched against Department of Defense (DoD), Combatant Commands (CCMD), Service, and other government organization priorities. Promising solutions are selected for further test and evaluation and, if successful, rapid prototyping or fielding to transition commercial ideas with military utility. These efforts support the Department's objectives of promoting effective competition, increasing speed to market, implementing technological and organizational innovation, and fielding affordable capabilities through innovation from commercial research and development. In FY 2017, Prototyping Through Non-Traditional Pathways conducted industry-wide engagements focused on the technology needs of the Department of Defense Sensors Community of Interest (COI), Electronic Warfare COI, Advanced Electronics COI, and the Joint Improvised-Threat Defeat Organization. ***FY 2018 Plans:***	3.000	3.100	3.100

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Prototyping Through Non-Traditional Pathways anticipates three to five reviews in FY 2018, and 15 to 20 resulting evaluations with potential for future prototypes. Each review focuses on identifying ideas in a specific topic area that can transition to meet joint operational needs through rapid prototyping. These reviews will be executed with DoD users and interagency partners including the Office of the Under Secretary of Defense for Intelligence, Cyber Science and Technology (S&T) Community of Interest, U.S. Special Operations Command S&T, Defense Health Agency, and Department of Homeland Security S&T. ***FY 2019 Plans:*** Prototyping Through Non-Traditional Pathways anticipates three to five reviews in FY 2019, and 15 to 20 resulting tests and evaluations with potential for future prototypes. Topics areas will be informed by DoD users and interagency partners based on priorities identified in the execution year. These reviews will be executed with DoD users and interagency partners. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Title: Open Source Data Analysis and Applications Focus Area ***Description:*** Open Source Data Analysis and Applications projects include the development of capabilities, software, and tools to analyze open source information. The data can be structured or unstructured and will include inputs from a broad spectrum of sources. Where possible these projects will exploit advanced learning systems and commercial technologies to provide solutions to emerging challenges in tracking targets, big data analytics, and extracting indications and warnings. Technologies developed within this focus area will reduce cost and analyst requirements to provide meaningful intelligence in support of the counter Islamic State of Iraq and the Levant (ISIL), counter weapons of mass destruction, and counter improvised explosive device missions. ***FY 2018 Plans:*** The Rapid Reaction Fund (RRF) investment decisions are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities and as new threats emerge or new opportunities are presented. RRF will support development of conceptual prototypes and new open source data analysis tools and applications to provide a hedge against emerging, irregular, and asymmetric threats. The program anticipates supporting six to eight projects in FY 2018. Deliverables will leverage emerging technologies to exploit open source information and reduce analyst requirements to provide actionable intelligence. ***FY 2019 Plans:*** The RRF investment decisions are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities and as new threats emerge or new opportunities are presented. The program anticipates supporting six to	-	6.620	6.832

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
eight projects in FY 2019. Deliverables will leverage emerging technologies to exploit open source information and reduce analyst requirements to provide actionable intelligence. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Autonomous Systems and Behaviors Focus Area ***Description:*** Autonomous Systems and Behaviors projects demonstrate capabilities to enhance joint forces, reduce the time to make critical decisions, and protect warfighters through increased use of autonomous and human-machine collaborative systems. Example projects include power systems to facilitate increased performance of unmanned systems, enhanced capabilities for multiple autonomous systems to cooperatively interact, autonomous operation in complex terrain, development of sensors for integration aboard unmanned platforms, improvements to data ex-filtration from unmanned sensors, human-machine collaborative decision making, and experiments to counter emerging unmanned threats from potential adversaries. These projects will also examine common software platforms to reduce development cost, increase collaboration among manned and unmanned vehicles, increase agility through rapid customization of autonomous systems' architectures, and inform requirement decisions for the autonomy community of interest to design affordable systems. ***FY 2018 Plans:*** RRF investment decisions for Autonomous Systems and Behaviors are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities. Selected projects will support development of components, payloads, and autonomous aerial, surface, and subsurface systems. RRF anticipates supporting six to seven projects in FY 2018. ***FY 2019 Plans:*** RRF investment decisions for Autonomous Systems and Behaviors are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities. RRF anticipates supporting six to seven projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.	-	5.429	5.821
Title: Urban Characterization Focus Areas ***Description:*** Future military operations will likely occur in a broad range of urban environments with complex radio frequency (RF), topological, situational awareness, and mobility challenges. Urban Characterization Focus Area projects will identify,	-	3.624	3.819

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
analyze, and describe typical urban areas for modeling, simulation, and planning purposes. These efforts will inform and enable development of intelligence, surveillance, and reconnaissance (ISR); electronic warfare; kinetic and non-kinetic effects; and, other capabilities needed for future military operations in a wide range of urban areas. ***FY 2018 Plans:*** The RRF investment decisions for Urban Characterization projects are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities. As new threats emerge and new opportunities are presented, RRF will select projects to demonstrate capabilities for Urban Characterization. RRF anticipates supporting four to five projects in FY 2018. Deliverables will include conceptual prototypes, modeling, and simulations to support planning efforts. ***FY 2019 Plans:*** The RRF investment decisions for Urban Characterization projects are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities. RRF anticipates supporting four to five projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Rapid Prototyping for Intelligence, Surveillance, and Reconnaissance (ISR) Focus Area ***Description:*** ISR sensors are critical for providing asymmetric compensation against larger, near-peer adversaries. However, ISR systems span a wide range of sensing modalities and generally produce very large data sets that are difficult to analyze. Efforts in this focus area will increase speed to market for better sensors and tools to more effectively analyze or visualize ISR data. Projects include improved surveillance sensors; tools to facilitate analysis of large data sets; methods to harvest meaningful intelligence from open and classified sources; and, establishment of more effective processing, exploitation, and dissemination capabilities. RRF sponsored prototypes will facilitate integration of advanced ISR capabilities into new and existing systems. These prototypes will help increase the effectiveness of ISR architectures and reduce the human analyst requirement to produce actionable intelligence. ***FY 2018 Plans:*** RRF investment decisions for ISR prototypes are made during the execution years in response to Department, CCMD, Service, and other government organization priorities and as new threats emerge or new opportunities are presented. Research and coordination with organizations throughout DoD and other government agencies will help identify areas critical to developing	-	5.179	4.971

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
future ISR capabilities. RRF anticipates supporting five to seven projects in FY 2018. Deliverables will include prototype systems, analytical capabilities, and software for a variety of platforms. ***FY 2019 Plans:*** RRF investment decisions for ISR prototypes are made during the execution years in response to Department, CCMD, Service, and other government organization priorities. RRF anticipates supporting five to seven projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Additive Manufacturing Focus Area ***Description:*** This focus area will develop the enabling capabilities and key technologies required to advance and secure additive manufacturing technology to meet specific warfighter needs. Additive manufacturing projects are those that use processes in which successive layers of material are laid down under computer control to create functional three dimensional products. Additive manufacturing allows for rapid prototyping and iterative innovation, removing barriers for technology insertion. Due to increased speed from design to prototype, reduced cost, and reduced waste, additive manufacturing provides a unique supporting capability for maintaining a U.S. competitive advantage. This focus area will leverage swiftly-developing commercial innovation and emerging capabilities of the Federally Funded Research and Development Centers (FFRDCs), government laboratories, and academia to develop conceptual prototypes focused on warfighter needs. Projects include spare part replacement, jet engine repair, custom hardware enclosures, and three-dimensional (3-D) models. Projects have the potential to significantly improve supply chain efficiencies by storing parts as software and manufacturing on demand, and by using rapid prototyping to reduce the time and cost of design. Projects can also reduce amount of labor required to produce functioning prototypes. Projects will also investigate security of additive manufacturing technologies and digital schematics. Deliverables will inform enhancement decisions and concept of operations development. ***FY 2018 Plans:*** Rapid Reaction Fund (RRF) investment decisions are made during the execution years in response to Department, Combatant Commands (CCMD), Service, and other government organization priorities and as new threats emerge or new opportunities are presented. For additive manufacturing projects this agility supports leveraging new capabilities developed by commercial industry. Research and coordination with organizations throughout Department of Defense (DoD) and other government agencies will help identify needs that could be addressed by future capabilities within the additive manufacturing field. RRF anticipates supporting five to seven projects in FY 2018. ***FY 2019 Plans:***	-	5.110	5.810

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 828 / *Rapid Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
RRF investment decisions are made during the execution years. The selection of future additive manufacturing projects will be based on priorities throughout DoD and other government agencies, and new opportunities for additive manufacturing. RRF anticipates supporting five to seven projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Maritime Dominance Technology Focus Area	-	5.656	5.791
Description: This focus area will develop the enabling capabilities and key technologies required to maintain maritime dominance, drawing the Chairman's Gap Assessment and strategic guidance from the new Under Secretary of Defense for Research and Engineering. Major drivers in the maritime domain include the development of extra-large, large, and small families of multi-mission unmanned undersea vehicles (UUVs), and the rapid growth of commercial undersea activity. The DoD is exploring emerging concepts for ubiquitous undersea communications, command and control, and large-scale UUV capabilities. To enable these concepts, RRF will focus on developing capabilities and technologies such as undersea power production, storage, and distribution; enhanced signal processing; autonomy; undersea situational awareness and navigation; sensors; undersea communications; and advanced materials development and production. ***FY 2018 Plans:*** The RRF investment decisions for Maritime Dominance Technology focus area are made during the execution years in response to Department, CCMD, Service, and other government organization priorities. As new threats emerge or new opportunities are presented RRF will select projects to demonstrate new payloads, better sensors, and new undersea systems to enhance deterrence. RRF anticipates supporting eight to nine projects in FY 2018. ***FY 2019 Plans:*** The RRF investment decisions for Maritime Dominance Technology focus area are made during the execution years in response to Department, CCMD, Service, and other government organization priorities. RRF anticipates supporting eight to nine projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Title: Prototyping Through Novel Reuse of Commercial-Off-the–Shelf (COTS) Technologies Focus Area	-	2.150	2.209

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 828 / *Rapid Reaction Fund*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Description: This effort increases impact and responsiveness of prototyping efforts through the reuse and repurposing of existing commercial and governmental technologies. Frequently, systems developed for a separate application provide a partial solution to new emerging challenges. By building new prototypes around a core of proven technologies, this effort reduces development and adoption risk in addition to controlling cost. This focus area provides RRF with agility by leveraging existing technologies to develop new prototypes and demonstrations. ***FY 2018 Plans:*** The Rapid Reaction Fund (RRF) investment decisions for COTS-based prototypes are made during the execution years in response to Department, CCMD, Service, and other government organization priorities and as new threats emerge or new opportunities are presented. Projects identified include efforts to repurpose commercial communication protocols into an electronic warfare capability, airport radar systems for bird alerts repurposed for counter-unmanned aircraft system (UAS), and commercial network security platforms. RRF anticipates supporting two to three projects in FY 2018. ***FY 2019 Plans:*** The RRF investment decisions for COTS-based prototypes are made during the execution years in response to Department, CCMD, Service, and other government organization priorities. RRF anticipates supporting two to three projects in FY 2019. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2017 and FY 2018 funding levels are lower than the baseline for this focus area, which is listed under FY 2019. This is because once projects are selected and funded during the years of execution (FY 2017/2018), the funds for these projects are reported elsewhere in this R-2. Projects have not been selected for FY 2019.			
Accomplishments/Planned Programs Subtotals	49.203	43.418	43.753

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

In FY 2019, performance metrics applicable to the Rapid Reaction Fund (RRF) include the DoD Strategic Performance goal to transition 40 percent of completing demonstration programs per year. In addition, project performance metrics are specific to each effort and include measures identified in individual project plans. Project completions and successes are monitored against schedules and deliverables stated in the proposals and statements of work. The metrics include items such as target

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
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milestone dates, specific performance measures, fielding dates, and demonstration goals. For projects completed in FY 2017, the RRF achieved a transition rate of approximately 80 percent.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018

Appropriation/Budget Activity	**R-1 Program Element (Number/Name)**	**Project (Number/Name)**
0400 / 3	PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	831 / *Joint Rapid Acquisition Cell Support*

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
831: *Joint Rapid Acquisition Cell Support*	7.978	1.583	1.652	1.669	-	1.669	1.685	1.702	1.719	1.736	Continuing	Continuing

A. Mission Description and Budget Item Justification

This funding includes support for the Joint Rapid Acquisition Cell (JRAC) to enable management and tracking of Combatant Command (CCMD) identified and Joint Staff validated immediate warfighter needs. The JRAC is responsible to:
(1) Coordinate review of validated Joint Urgent Operational Needs (JUON) and Joint Emergent Operational Needs (JEON) and assign responsibility to appropriate DoD Components for timely funding and resolution.
(2) Serve as the review and approval authority for the DoD Components’ strategy to fund and mitigate the identified JUON/JEON capability gaps.
(3) Continually assess actions taken by the DoD Components to resolve JUONs/JEONs and recommend to the Under Secretary of Defense for Research and Engineering any changes determined appropriate to improve their responsiveness to JUONs/JEONs.
(4) Provide periodic reports to the Secretary of Defense on new and outstanding JUONs/JEONs.
(5) In coordination with Under Secretary of Defense Comptroller (USD(C)), manage the Rapid Acquisition Fund (RAF) to allocate resources to priority unfunded JUONs/JEONs.
(6) In coordination with the Office of the Chairman of the Joint Chiefs of Staff and the USD(C), make programmatic, budget, and acquisition recommendations for JUONs and identify capability gaps to the Secretary of Defense.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Joint Rapid Acquisition Cell (JRAC) Management Support ***Description:*** This funding is used to support the staff manning of the JRAC to enable management and tracking of CCMD identified and Joint Staff validated immediate warfighter needs. ***FY 2018 Plans:*** Continue support for the JRAC management and tracking of CCMD initiatives. Continue validation of the warfighter needs by the Joint Staff. ***FY 2019 Plans:*** Continue support for the JRAC management and tracking of CCMD initiatives. Continue validation of the warfighter needs by the Joint Staff. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	1.583	1.652	1.669

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 831 / *Joint Rapid Acquisition Cell Support*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations and growth consistent with inflation.			
Accomplishments/Planned Programs Subtotals	1.583	1.652	1.669

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A – Capabilities acquired to fulfill Joint Urgent Operational Needs (JUON) and Joint Emergent Operational Needs (JEON) are provided by other DoD components.

E. Performance Metrics

Joint Rapid Acquisition Cell performance metrics are specific to each JUON/JEON and include measures identified in the management approach for each action. In addition, JUON/JEON completions and successes are monitored against schedules and deliverables stated in the management approach. The metrics that JRAC support correlates to is the number of full time personnel identified in the JRAC support contract with associated pay rates and shall not exceed the specified amounts or hourly rates and/or firm fixed price.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 833 / *Strategic Multi-Layered Assessment (SMA) Support*	

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
833: *Strategic Multi-Layered Assessment (SMA) Support*	8.496	2.208	2.305	2.328	-	2.328	2.351	2.375	2.399	2.423	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Strategic Multi-Layered Assessment (SMA) Cell supports all Combatant Commands (CCMDs), Joint Force Commanders, and other government agencies by assessing complex operational and technical challenges, which require collaborative multi-agency and multi-disciplinary approaches. With input from across the U.S. Government, academia, and the private sector, the SMA Cell develops options to CCMD-generated challenging problems and informs the command's senior leadership. Each SMA effort is initiated at the request of senior CCMD leadership and priorities for SMA problems are set by the Joint Staff Deputy Director for Global Operations. Products are typically produced within six months and directly contribute to the decision making process of CCMD's senior leaders. SMA is also supported by the Rapid Reaction Fund (RRF).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Assessing ‘Gray Zone’ Conflicts for the U.S. Security Coordinator (USSC), U.S. European Command (USEUCOM), U.S. Special Operations Command (USSOCOM), and U.S. Strategic Command (USSTRATCOM) ***Description:*** The SMA Cell started a strategic analysis effort at the request of the United States Security Coordinator for Israel and the Palestinian Authority. The effort evaluated strategic risks and identified knowledge gaps to provide an increased understanding of potential security environments and their implications for Palestinian security sector reform. USEUCOM subsequently asked SMA to apply the same methodology to identify emerging Russian threats and opportunities in Eurasia. Building on these efforts, USSOCOM requested that the SMA cell assess how the U.S. Government can diagnose, identify, and assess indirect strategies, and develop response options against associated types of Gray Zone challenges. SMA completed several actor and social media analyses including Virtual Think Tank Assessments (ViTTa) that provided summarized subject matter expert (SME) analyses to USSOCOM. The assessing ‘Gray Zone’ support to USSOCOM concluded in FY 2017.	0.595	-	-
Title: Strategic Multi-Layered Assessment (SMA) Cell ***Description:*** The SMA Cell provides planning support to Combatant Commands (CCMDs) and U.S. Government agencies, along with actionable assessments for complex operational and technical challenges to help maintain our competitive advantage in an increasingly complex global environment. Challenges addressed with SMA efforts require multi-agency, multi-disciplinary approaches that are not within the customer organization’s core competency. The SMA Cell identifies options from across the U.S. Government, academia, and the private sector. SMA efforts are facilitated by the Joint Chiefs of Staff/J-3 Operations and are executed by the Office of the Under Secretary of Defense, Research and Engineering. In FY 2017, the SMA Cell focused on questions and challenges posed by U.S. Central Command and U.S. European Command. Specifically, SMA established a community of over 200 subject matter experts and responded to 53 separate U.S. Central Command priority questions.	1.613	2.305	2.328

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603826D8Z / *Quick Reaction Special Projects (QRSP)*	**Project (Number/Name)** 833 / *Strategic Multi-Layered Assessment (SMA) Support*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: With USSTRATCOM coordination the Air Force requested SMA initiate a multi-disciplinary, multi-agency portfolio of projects to assess and study contested space operations from a wide range of perspectives. The purpose of this study is to examine how the U.S. Government can retain competitive advantage in the space domain and counter any intent to deny U.S. and partner freedom of action in the space domain. ***FY 2019 Plans:*** The SMA Cell will continue to actively work with the CCMDs and the Joint Chiefs of Staff to identify challenging problems that are not within the traditional areas of DoD expertise. These problems will be in direct support of CCMD senior leadership and may include areas such as: counter terrorism, transnational criminal organizations, counter weapons of mass destruction (state and non-state), counter global or regional social and cultural assessments, regional stability assessments, and individual state or national level deterrence studies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations and growth consistent with inflation.			
Accomplishments/Planned Programs Subtotals	2.208	2.305	2.328

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

SMA performance metrics are specific to each effort and include measures identified in the specific project plans. In addition, project completions and successes are monitored against schedules and deliverables stated in the execution documents. Each project's results are reviewed by a senior review group that is comprised with representatives from the Office of the Secretary of Defense, the Joint Chiefs of Staff, the Combatant Commands, and outside subject matter experts. The ultimate measure of success is adoption and transition of SMA products by the CCMD and supporting entities. In FY 2017, SMA products were delivered to senior leadership and staff at U.S. Special Operations, U.S. Central Command, and U.S. European Command.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*

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	17.904	22.198	25.395	19.415	-	19.415	19.431	14.556	14.770	14.963	Continuing	Continuing
401: *DoD Modeling and Simulation Management Office*	3.296	3.158	10.519	4.609	-	4.609	4.701	4.795	4.891	4.989	Continuing	Continuing
402: *Systems Engineering Research Center*	4.869	4.531	4.930	4.904	-	4.904	4.928	4.946	4.942	4.937	Continuing	Continuing
403: *Engineered Resilient Systems*	9.739	14.509	9.946	9.902	-	9.902	9.802	4.815	4.937	5.037	Continuing	Continuing

Note

Service Requirements Review Board (SRRB) efficiencies are included.

A. Mission Description and Budget Item Justification

This Program Element (PE) addresses Defense Research and Engineering priorities to advance engineering state of the practice, and complex defense systems challenges through development of engineering capabilities to improve acquisition quality. Engineering science and technology, including modeling and simulation (M&S), systems engineering (SE) research, and engineering capabilities for resilience, supports the cost-effective acquisition of complex systems in support of the full range and scope of Department of Defense (DoD) missions and operations.

M&S is a key enabler of DoD capabilities; underpins innovative solutions meeting real-world national security challenges and ensuring technical superiority; acts as a force multiplier; saves resources; and saves lives. The DoD Modeling and Simulation Management Office (MSMO), designated by the Office of the Under Secretary of Defense, Research and Engineering (OUSD(R&E)) to be the focal point and advocate for DoD M&S, enhances the DoD M&S Enterprise by (1) enabling joint and cross-cutting cooperation and collaboration in identifying, developing and sustaining modeling and simulation solutions; and (2) promoting technology solutions, including common M&S architectures, standards, and services that improve interoperability, reuse, and cost effectiveness of DoD M&S.

The Systems Engineering Research Center (SERC) is a University Affiliated Research Center (UARC) established in 2008 as a strategic resource to further systems research and increase its impact on the Department's ability to meet its mission. Greatly improved SE methods, processes and tools are essential to the DoD strategy to field systems that are agile, affordably sustainable, flexible, and ready for a full range of contingencies in the face of declining budgets and a shrinking workforce. The SERC consists of a network of 23 research universities from across the U.S. that work collaboratively to bring the best talent in the nation to bear on DoD's systems engineering research problems.

Engineered Resilient Systems (ERS) addresses the need for achieving more affordable and mission-resilient warfighting systems designed within a shorter time frame by conducting research and development and new concepts for implementing an integrated suite of modern computational engineering tools, modeling capabilities, and tradespace assessment and visualization tools within an architecture aligned with acquisition and operational business processes. These integrated tools will operate

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603833D8Z *I Engineering Science and Technology (S&T)*

within a framework that supports data-driven decision-making in an innovative environment that enables advanced knowledge management and multi-community collaboration, including data retention and lessons learned.

B. Program Change Summary ($ in Millions)

	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	17.659	25.395	19.884	-	19.884
Current President's Budget	22.198	25.395	19.415	-	19.415
Total Adjustments	4.539	0.000	-0.469	-	-0.469
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	5.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.432	-			
• Other Program Adjustments	-0.003	-	-0.339	-	-0.339
• FFRDC Transfer	-0.026	-	-	-	-
• Economic Assumption	-	-	-0.130	-	-0.130

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

	FY 2017	FY 2018
Project: 403: *Engineered Resilient Systems*		
Congressional Add: *Computational Research and Engineering Acquisition Tools and Environments (CREATE)*	5.000	-
Congressional Add Subtotals for Project: 403	5.000	-
Congressional Add Totals for all Projects	5.000	-

Change Summary Explanation

The FY 2017 baseline adjustment of $5M was added for Engineering Resilient Systems to focus on mission-relevant trade-space analysis and cost reduction pre-milestone B.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 401 / *DoD Modeling and Simulation Management Office*

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
401: *DoD Modeling and Simulation Management Office*	3.296	3.158	10.519	4.609	-	4.609	4.701	4.795	4.891	4.989	Continuing	Continuing

A. Mission Description and Budget Item Justification

Modeling and Simulation (M&S) supports the full range and scope of Department of Defense (DoD) missions and operations, including joint and cross-cutting. M&S is a key enabler of DoD capabilities; underpins innovative solutions meeting defense and national security challenges to ensure technical superiority, and saves resources. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)), under the authority of DoD Directive 5134.01, designated the DoD Modeling and Simulation Management Office (MSMO) to be the focal point and advocate for Defense M&S to enhance the Defense M&S Enterprise by (1) enabling cooperation and collaboration in identifying, developing and sustaining modeling and simulation solutions; and (2) promoting technology solutions, including common M&S architectures, standards, and services that improve interoperability, reuse, and cost effectiveness of DoD M&S. MSMO executes its efforts in accordance with the USD(AT&L)-promulgated DoD Directive 5000.59, "Management of Modeling and Simulation" and DoD Instruction 5000.70, "Management of DoD Modeling and Simulation (M&S) Activities;" and other DoD Issuances, including DoD 4120.24-M, "DoD Standardization Program (DSP) Policies and Procedures" and DoD Instruction 3200.14, "Principles and Operational Parameters of the DoD Scientific and Technical Information Program."

MSMO is responsible for:
• Planning, coordinating, and managing funds to support enterprise-level joint and cross-cutting M&S activities that guide the Defense M&S Community to achieve the DoD Strategic Vision for M&S.
• Bringing together M&S stakeholders to advise and assist on finding solutions for removing the barriers to interoperability, reuse, commonality, efficiency, and effectiveness.
• Developing, coordinating, and advocating for policy/guidance, technology, standards, best practices, and strategic planning processes that promote interoperability and reuse across the Department.

MSMO also serves as DoD's:
• Focal point and advocate for coordinating M&S information exchanges and interactions within DoD, with other U.S. Government departments and agencies, international allies, industry, and academia to promote sharing of information and practices, synergy of efforts, and M&S as a key enabler of all organizations' missions.
• Lead Standardization Activity (LSA) for managing M&S standards and methodologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: DoD Modeling and Simulation Management Office (MSMO) ***Description:*** MSMO, as the USD(AT&L)-designated focal point for Defense modeling and simulation (M&S), is responsible for maintaining and enhancing policies, standards, technology, and collaboration to ensure the efficiency and effectiveness of the M&S that supports the full range and scope of DoD missions and operations.	3.158	10.519	4.609

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 401 / *DoD Modeling and Simulation Management Office*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
MSMO: (1) conducts management and technical support for the Department's current and long-term M&S needs; (2) responds to opportunities to leverage relevant DoD Information Technology (IT) enterprise capabilities and DoD-, Industry-, and Academia-developed M&S technologies; and (3) advocates an enterprise approach for the future of DoD M&S, maintaining strong engagement and ties with Defense and external community stakeholders. ***FY 2018 Plans:*** Integrated Defense Analytic Capability: • Leveraging the FY 2017 assessment, develop and prototype use cases illuminating integration of Intelligence into analysis supporting acquisition decisions using Blue and Red models in an appropriate simulation environment in a joint concept. Policy and Guidance: • Initiate a DoD M&S Strategy to guide the Department's planning for and investing in M&S capabilities and tools, to include conducting a gap analysis for Defense M&S to inform the strategy. • Assist Services and Defense Agencies in development of their Verification, Validation, and Accreditation (VV&A) plans. Standards: • Serve as the Lead Standardization Activity for M&S Standards and Methodologies, and/or lead and participate in Defense Standardization Program Office and Joint Enterprise Standards Committee activities and International standards activities such as NATO Standardization Agreements for M&S to promote open architectures and standards. • Refine the Defense M&S Reference Architecture to maintain consistency with changes to the overall DoD IT policies and infrastructure. Technology: • Develop, enhance, and advocate the M&S enterprise suite of tools to improve joint and cross-cutting M&S capabilities. • Chair M&S Community of Interest, Cyber M&S Technical Working Group, and M&S Architecture Working Group.Perform technology watch/horizon scanning related to M&S emerging capabilities. Collaboration: • Represent U.S. interests in International M&S activities: – Serve as the Chair of the NATO M&S Group (NMSG) and participate in NMSG task groups. • Collaborate with interagency organizations, as required. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 401 / *DoD Modeling and Simulation Management Office*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Integrated Defense Analytic Capability: • Following FY 2018 limited prototype, develop and standardize a capability for incorporating Intelligence into analysis for acquisition decision issues using Blue and Red models in an appropriate simulation environment in a joint concept. • Expand Community of Practice focusing on high-fidelity, joint mission simulation capabilities to enable acquisition professionals and warfighters to leverage these capabilities. Policy and Guidance: • Publish a DoD M&S Strategy to guide the Department's planning for and investing in M&S capabilities and tools. • Assist Services and Defense Agencies in development of their Verification, Validation, and Accreditation (VV&A) plans. Standards: • Serve as the Lead Standardization Activity for M&S Standards and Methodologies, and/or lead and participate in Defense Standardization Program Office and Joint Enterprise Standards Committee activities and International standards activities such as NATO Standardization Agreements for M&S. • Enhance the Defense M&S Reference Architecture with additional patterns identified through user feedback. Technology: • Develop, enhance, and advocate the M&S enterprise suite of tools to improve joint and cross-cutting M&S capabilities. • Chair M&S Community of Interest, Cyber M&S Technical Working Group, and M&S Architecture Working Group. • Perform technology watch/horizon scanning related to M&S emerging capabilities to provide investment shaping and strategic direction. Collaboration: • Work with Defense stakeholders, continue and refine Department-wide M&S gaps monitoring and reduction capability, • Represent U.S. interests in International M&S activities: - Collaborate with the NATO M&S Group (NMSG) and participate in NMSG task groups. • Collaborate with interagency organizations, as required. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2018 increase for one year congressional mandated study. In FY 2019, funding resumes as previous.			
Accomplishments/Planned Programs Subtotals	3.158	10.519	4.609

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 401 / *DoD Modeling and Simulation Management Office*

C. Other Program Funding Summary ($ in Millions)

Remarks

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance in this program is monitored in the following ways:

- Number of instances where M&S standards, technical best practices, or tools have been adopted or employed.
- Number of M&S resources (tools, data, and services) made visible or updated in the DoD M&S Enterprise Catalog for reuse and the completeness of each record according to DoD discovery metadata standards.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 402 / *Systems Engineering Research 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
402: *Systems Engineering Research Center*	4.869	4.531	4.930	4.904	-	4.904	4.928	4.946	4.942	4.937	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Systems Engineering Research Center (SERC) is a University Affiliated Research Center (UARC) established in 2008 as a strategic resource to further systems research and increases its impact on the Department's ability to meet its mission. Greatly improved SE is essential to DoD's strategy to field systems that are agile, affordably sustainable, flexible, and ready for a full range of contingencies in the face of declining budgets and a shrinking workforce.

The SERC's network of universities is led by the Stevens Institute of Technology, and includes the Air Force Institute of Technology, Auburn University, Carnegie Mellon University, Georgetown University, Georgia Institute of Technology, Massachusetts Institute of Technology, Missouri University of Science and Technology, Naval Postgraduate School, North Carolina Agricultural and Technical State University, Pennsylvania State University, Purdue University, Southern Methodist University, Texas A&M University, Texas Tech University, University of Alabama, University of California, University of Maryland, University of Massachusetts, University of Southern California, University of Virginia, and Wayne State University. These Universities work collaboratively to bring the best talent in the nation to bear on DoD's systems engineering research problems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Systems Engineering Research Center ***Description:*** The SERC is a DoD UARC which conducts University-based research that directly supports DoD's Strategic Plan through development of new systems engineering methods, processes and tools. ***FY 2018 Plans:*** Continue to enhance engineering methods, processes and tools (MPTs) to improve in the following areas: • Systems Engineering Transformation: transform current systems engineering methods to enable rapid, concurrent and scalable definition and affordable development of flexible systems that are responsive to changing threats and missions; – Apply and validate tools to understand tradeoffs in affordability and other system qualities. • Enterprises and Systems of Systems: create foundational methods to develop and design enterprises and system of systems to provide an overwhelming competitive advantage over our adversaries; – Complete pilot application of System of Systems Analytic Workbench with Naval Systems Warfare Center. • Trusted Systems: secure defense systems from cyber and other threats through systemic security and assurance approaches that complement incomplete current perimeter/network defense methods;	4.531	4.930	4.904

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 402 / *Systems Engineering Research Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
– Evaluate results of pilot application of formal methods for resilient systems with a focus on autonomous vehicles. • Human Capital Development: speed the professional development of highly capable systems engineers and technical leaders in the Department and the Defense Industrial Base. – Establish library of courses for the Systems Engineering Experience Accelerator. ***FY 2019 Plans:*** Continue to enhance engineering methods, processes and tools (MPTs) to improve in the following areas: • Systems Engineering Transformation: transform current systems engineering methods to enable rapid, concurrent and scalable definition and affordable development of flexible systems that are responsive to changing threats and missions; – Develop and apply behavior specification framework to improve assessment of autonomous systems. • Enterprises and Systems of Systems: create foundational methods to develop and design enterprises and system of systems to provide an overwhelming competitive advantage over our adversaries; – Develop and apply models to gauge expected results from composition of diverse, modular components and systems. • Trusted Systems: secure defense systems from cyber and other threats through systemic security and assurance approaches that complement incomplete current perimeter/network defense methods; – Development and trial applications of model-based system assurance methods. • Human Capital Development: speed the professional development of highly capable systems engineers and technical leaders in the Department and the Defense Industrial Base. – Develop of model and technical report identifying methods for organizations to improve their engineering workforce along with the expected benefits. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Accomplishments/Planned Programs Subtotals	4.531	4.930	4.904

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 402 / *Systems Engineering Research Center*

D. Acquisition Strategy

N/A

E. Performance Metrics

Develop and extend fundamental knowledge, advanced methods, processes and tools and cutting edge techniques for systems engineering of complex designs of relevance to the DoD mission.

- Promulgation of advanced System Engineering approaches through research publications, presentations and monographs.
- Adoption of SERC methods, processes, and tools into DoD component activities.

FY 2018 Accomplishments:
Enhanced engineering methods, processes and tools (MPTs) to improve in the following areas:

• Systems Engineering Transformation: transform current systems engineering methods to enable rapid, concurrent and scalable definition and affordable development of flexible systems that are responsive to changing threats and missions;
– Completed empirical studies in model-centric decision-making and multi-stakeholder tradespace exploration.

• Enterprises and Systems of Systems: create foundational methods to develop and design enterprises and system of systems to provide an overwhelming competitive advantage over our adversaries;
– Completed development of the System of Systems Analytic Workbench. Pilot applications at DoD laboratories and Federal Funded Research and Development Centers.

• Trusted Systems: secure defense systems from cyber and other threats through systemic security and assurance approaches that complement incomplete current perimeter/network defense methods;
– Developed metrics to gauge the complexity of attack surface of weapon systems, and developed design selection tools to determine best methods to mitigate threats.
Human Capital Development: speed the professional development of highly capable systems engineers and technical leaders in the Department and the Defense Industrial Base.
–Systems Engineering Experience Accelerator courses used Defense Acquisition University, several U.S. universities and United Kingdom Ministry of Defense.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 403 / *Engineered Resilient 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
403: *Engineered Resilient Systems*	9.739	14.509	9.946	9.902	-	9.902	9.802	4.815	4.937	5.037	Continuing	Continuing

A. Mission Description and Budget Item Justification

Engineered Resilient Systems (ERS) improves design agility and cost-effectiveness during analysis and development leading to improvements in testing, manufacturing, and fielding of mission-effective and adaptable systems. Its products are engineering design visualization and tool integration frameworks that will integrate physics-based models and engineering tools across acquisition disciplines to vastly improve the ability to perform tradespace and requirements analysis, iteratively optimize designs and improve architectures to reduce or eliminate sensitivity to adversary tactics and capability improvements, and adapt those designs over time. The goal is to provide new pathways to acquisition and achieve a vitally-needed transformation in the contribution of Defense systems engineering to design resilience and effectiveness across the systems lifecycle. These engineering improvements are essential to accelerate capability to the warfighter and address a geopolitical environment marked by rapidly changing threats, tactics, missions and technologies, and fiscal constraints. The pace of change renders current point-design approaches unsustainable in both cost and time.

ERS research and development focuses on new concepts for implementing an integrated suite of modern computational engineering tools, models, simulations and related capabilities, and tradespace assessment and visualization tools within an architecture aligned with acquisition and operational business processes. These integrated tools will operate within a framework that supports transparency, inclusion and data-driven decision-making in an innovative environment that provides advanced knowledge management, including data retention and lessons-learned, and enables multi-community collaboration. ERS leverages multi-fidelity physics-based models developed by the S&T community to inform the acquisition decision process (e.g., increased/easier utilization of High Performance Computing, web-based analysis with large data sets, and lifecycle cost sensitivity analysis). These new computational and model-based frameworks adapt advanced design and modeling approaches from Government, industry, and academia to enable our Nation to affordably deliver warfighting capability. ERS provides the capability to fully explore and identify key performance parameters and inform the requirements process. With ERS, DoD is buying down the risk of future systems by using high-fidelity modeling and advanced analyses of design options, as well as linking candidate platforms to traditional modeling and simulation toolkits and employing DoD's high-performance computing assets.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Engineered Resilient Systems (ERS) ***Description:*** Engineered Resilient Systems (ERS) addresses the need for achieving more affordable, technically superior and mission-resilient warfighting systems designed within a shorter time frame by conducting research and development and new concepts for implementing an integrated suite of modern computational engineering tools, modeling capabilities, and tradespace assessment and visualization tools within an architecture aligned with acquisition and operational business processes. These integrated tools will operate within a framework that supports transparency, inclusion and data-driven decision-making in an innovative environment that enables advanced knowledge management and multi-community collaboration, including data	9.509	9.946	9.902

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 403 / *Engineered Resilient Systems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
retention and lessons learned. The work being done through the ERS program currently spans all services and aids in analyses of fixed-wing planes, rotorcraft, ground vehicles and ships. The services use ERS to test and prove new technology solutions prior to major technology investments. ***FY 2018 Plans:*** Conceptual, Computational, and World-Wide Environmental Representation: Develop simulations of ground vehicle dynamics under varying physical and relative conditions; apply physics to analysis, integration and testing of NGA, Air Force, Navy, and Army environmental data sets. Continue to extend mission context analysis and evaluation to multiple environmental simulations. Test and integrate automatic computational scenario development with simulation parameter settings. Provide automated workflows with user-selected model-based simulations. Mission-Relevant Engineering Tradespace Analysis: Improve and test primary framework for ERS next-generation tradespace analysis tools providing user-requirements in data package management, statistical analysis, automated data storage and advanced visualization; Implement and test sub-system analysis in trades; enhance and test user interfaces; enhance integration of tradespace analytics with ERS open system in mapping to acquisition users requirements and Defense Acquisition processes; apply tradespace capability to fixed-wing manned/unmanned, ground vehicle, modular ship design and service requested Joint Capability Technology Demonstration projects. Capability Integration and Demonstration: Enrich and extend open architecture design by collecting and integrating DoD acquisition and industry user requirements, implemented in an open system model, allowing for feedback, evaluation, and enhancements. Implement and evaluate information assurance security architecture, perform vulnerability analyses, and integrate intellectual property management capability within can ERS computational framework. Align ERS tools and capabilities to Defense acquisition processes. Collaborative Engineering Analysis and Engineering Decision-making: Enhance established methods to protect industry intellectual property and provide lessons-learned repository for creating and collaborating between DoD research & development, DoD acquisition, and industry partners. Provide mature knowledge management environment for tradespace analysis using facilities at the Defense Technical Information Center. ***FY 2019 Plans:*** Conceptual, Computational, and World-Wide Environmental Representation: Develop, integrate, and evolve computational tools to support additional applications and novel approaches in warfare domains including surface ships and submarines, ground vehicles, fixed-wing and rotary-wing aircraft, sensors, electronic warfare, and hypersonics; continue to facilitate the rapid			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 403 / *Engineered Resilient Systems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
development of environmental scenarios; and utilize physics-based tools to assess the impact of a variety of physical conditions on DoD materiel in operationally relevant environments. Mission-Relevant Engineering Tradespace Analysis: Improve and test primary framework for ERS next-generation tradespace analysis tools with data package management, data storage, statistical analysis, and advanced visualization; enhance and test user interfaces; explore tool deployment for multiple classification levels; develop linkage between system requirements and tradespace analysis; and apply tradespace capability to fixed-wing and rotary-wing air vehicle, ground vehicle, and ship design. Capability Integration and Demonstration: Leverage DoD acquisition and industry user requirements to enrich and extend open architecture design, allowing for feedback, evaluation, and enhancements; integrate multiple disciplines into ERS workflows such as high-fidelity fluid dynamics, structural mechanics, cost, and performance determination models; automate the execution of existing numerical simulations on DoD high-performance computing platforms; and integrate capabilities for a mixed classification user base requiring varied approaches. Collaborative Engineering Analysis and Engineering Decision-making: Extend established methods to protect industry intellectual property and provide a lessons-learned repository for creating and collaborating between DoD research & development, DoD acquisition, and industry partners; provide mature knowledge management environment using collaborative online communities; develop methodology for retaining tradespaces and other digital artifacts that are part of ERS early conceptual design activities; and leverage efforts to support digital engineering activities such as digital thread throughout the DoD. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Level of effort is consistent between FY 2018 and FY 2019. Small changes reflect minor budget fluctuations.			
Accomplishments/Planned Programs Subtotals	9.509	9.946	9.902

	FY 2017	FY 2018
Congressional Add: Computational Research and Engineering Acquisition Tools and Environments (CREATE)	5.000	-
FY 2017 Accomplishments: This work specifically addresses a need to automate workflows that include computational physics tools developed by the DoD High Performance Computing Modernization Program (HPCMP) Computational Research and Engineering Acquisition Tools and Environments (CREATE) program and tradespace and data analytics tools developed by the ERS program. Workflow automation will enable design engineers and data analysts to make acquisition and operation decisions faster, as well as increase the value added of Physics-based modeling and big data analytics practices to engineering. Combining hard science, high performance computing and process improvement practices, provides a lasting enhancement to		

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603833D8Z / *Engineering Science and Technology (S&T)*	**Project (Number/Name)** 403 / *Engineered Resilient Systems*

	FY 2017	FY 2018
the broader DoD use of models, in some challenging areas, such as rotary and fixed wing performance, ship design, and 9 other platform specific challenges. This effort was fully coordinated and aligned with the work in Army PE 0603734A, Military Engineering Advanced Technology (Project T08).		
Congressional Adds Subtotals	5.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

- Development of a technological capability for DoD Science and Technology, academia, industry, and the requirements/acquisition communities to collaborate and provide an innovative and more effective means for engineering.
- Demonstration and evaluation of next-generation engineering methods and design tools, documented in analyses and technical reports.
- Use of Engineered Resilient Systems engineering methods and design tools.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603924D8Z / *High Energy Laser Advanced Development*

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	69.533	-	69.533	75.438	81.399	84.340	84.289	Continuing	Continuing
924: *High Energy Laser Initiative*	-	0.000	0.000	69.533	-	69.533	75.438	81.399	84.340	84.289	Continuing	Continuing

Note

This is not a new start. This work continues/expands on research initiated by the Missile Defense Agency in PE 0603178C (Weapons Technology) with the goal of focusing on common non-Service/Agency specific improvements in High Energy Laser (HEL) components/systems.

A. Mission Description and Budget Item Justification

This program element funds HEL advanced technology development aimed at translating technology solutions for broadly defined military problems into demonstrated performance pay-offs, increased capabilities, increased supportability, and/or increased affordability. HEL weapons systems have many potential advantages, including speed-of-light time-to-target, high precision, nearly unlimited magazine depth, low cost per kill, and reduced logistics requirements because of no need for stocks of munitions or warheads. As a result, HELs have the potential to perform a wide variety of military missions. Activities conducted under this program element will develop and demonstrate the technology necessary to enable HEL missions across the Department of Defense (DoD).

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	69.533	-	69.533
Total Adjustments	0.000	0.000	69.533	-	69.533
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• FY 2019 Program Start	-	-	70.000	-	70.000
• Economic Assumption	-	-	-0.467	-	-0.467

Change Summary Explanation

This funding will support the broad area of improved HEL capability, focusing on increased output power, improved beam quality, efficient power and thermal management schemes, and other common component activities that will benefit HEL programs across the DoD Enterprise. Similar research and developmental work is currently being undertaken by the Services/Agencies; therefore, activities within this PE will support and be closely coordinated with other DoD HEL efforts directed at specific Service and Agency missions.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603924D8Z / *High Energy Laser Advanced Development*	**Project (Number/Name)** 924 / *High Energy Laser 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
924: *High Energy Laser Initiative*	-	0.000	0.000	69.533	-	69.533	75.438	81.399	84.340	84.289	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element is part of an overall Department of Defense (DoD) strategy in High Energy Laser (HEL) science and technology development focused on scaling the output power of HELs to reach operationally effective power levels applicable to broad mission areas across the DoD. Efforts will also pursue improvements in common HEL system components such as efficient power and/or thermal management approaches, effective power supplies, and beam combining/beam director designs. This program element complements, and will be closely coordinated with, other DoD HEL efforts directed at specific Service and Agency missions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High Energy Laser Power Scaling ***Description:*** This effort is focused on scaling HEL power levels important to mission areas across the DoD, and will leverage and/or build upon other investments in HEL development. ***FY 2019 Plans:*** Implement a research strategy to scale the output power of HEL to meet Department-wide mission area needs based on findings from the DoD HEL Roadmap Assessment and other technical sources. Establish key performance metrics based on power, power-in-the-bucket (beam quality), electrical-optical efficiency, including size and weight constraints. Determine appropriate technologies and initiate the development efforts. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This funding will support the broad area of improved HEL capability, focusing on increased output power, improved beam quality, efficient power and thermal management schemes, and other common component activities that will benefit HEL programs across the DoD Enterprise. Similar research and developmental work is currently being undertaken by the Services/Agencies; therefore, activities within this PE will support and be closely coordinated with other DoD HEL efforts directed at specific Service and Agency missions.	0.000	-	69.533
Accomplishments/Planned Programs Subtotals	0.000	-	69.533

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603924D8Z / *High Energy Laser Advanced Development*	**Project (Number/Name)** 924 / *High Energy Laser Initiative*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/Science and 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	430.371	89.605	89.586	96.389	-	96.389	97.574	99.520	101.515	105.858	Continuing	Continuing
091: *High Speed Systems Test*	111.279	32.074	17.930	15.185	-	15.185	15.340	15.898	16.179	16.835	Continuing	Continuing
092: *Spectrum Efficient Technology*	41.068	9.193	9.011	10.682	-	10.682	10.253	10.566	10.782	11.248	Continuing	Continuing
093: *Electronic Warfare Test*	64.171	9.193	11.127	12.478	-	12.478	13.109	13.478	13.755	14.349	Continuing	Continuing
094: *Advanced Instrumentation Systems Technology*	49.168	4.883	10.004	11.517	-	11.517	12.524	12.886	13.150	13.718	Continuing	Continuing
095: *Directed Energy Test*	41.779	7.362	7.259	8.654	-	8.654	8.593	8.853	9.034	9.424	Continuing	Continuing
096: *C4I & Software Intensive Systems Test*	82.136	12.379	15.707	12.381	-	12.381	11.075	11.420	11.654	12.158	Continuing	Continuing
097: *Unmanned and Autonomous System Test*	23.314	10.316	11.168	14.490	-	14.490	13.692	13.105	13.374	13.952	Continuing	Continuing
098: *Cyberspace Test*	17.456	4.205	7.380	11.002	-	11.002	12.988	13.314	13.587	14.174	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Test and Evaluation/Science and Technology (T&E/S&T) Program seeks out and develops test technologies to keep pace with evolving weapons technologies. This program is critical to ensure that the Department of Defense (DoD) has the ability to adequately test the advanced systems that will be fielded in the future. To meet this objective, the T&E/S&T Program performs the following activities:

• Exploits new technologies and processes to meet important test and evaluation (T&E) requirements.
• Expedites the transition of new technologies from the laboratory environment to the T&E community.
• Leverages industry advances in equipment, modeling and simulation, and networking to support T&E.

Additionally, the T&E/S&T Program examines emerging T&E requirements resulting from Joint Service initiatives to identify T&E technology needs and develop a long-range roadmap for technology insertion. The program leverages and employs applicable applied research efforts from the highly developed technology base in DoD laboratories and test centers, other Government agencies, and industry to accelerate development of new test capabilities. The program outreaches and engages academia to address test technology challenges in DoD testing, advancing Science, Technology, Engineering and Mathematics (STEM) initiatives at Historically Black Colleges and Universities (HBCU) and other minority serving institutions. This program provides travel funds for T&E/S&T program oversight, special studies, analyses, and strategic planning related to test capabilities and infrastructure. The T&E/S&T Program aligns with the S&T Communities of Interest (COI) to prepare the T&E community to test warfighting capabilities that emerge from priority S&T investments. The T&E/S&T Program is funded within the Advanced Technology Development Budget Activity because it develops and demonstrates high payoff technologies for current and future DoD test capabilities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/Science and Technology*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	87.135	89.586	97.056	-	97.056
Current President's Budget	89.605	89.586	96.389	-	96.389
Total Adjustments	2.470	0.000	-0.667	-	-0.667
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	5.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.416	-			
• FFRDC Reduction	-0.101	-	-	-	-
• Inflation Adjustment	-	-	-0.667	-	-0.667
• Other Reduction	-0.013	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 091 / *High Speed Systems Test*	

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
091: *High Speed Systems Test*	111.279	32.074	17.930	15.185	-	15.185	15.340	15.898	16.179	16.835	Continuing	Continuing

A. Mission Description and Budget Item Justification

High-speed/hypersonic weapons are being developed to ensure the continued military superiority and strike capability of the United States including freedom of movement and freedom of action in areas protected by anti-access/area denial defenses. Current weapon system demonstrations and technology development programs include high-speed and hypersonic air-breathing missiles, maneuvering reentry and boost-glide weapons, hypersonic gun-launched projectiles, and air-breathing space access vehicles. These systems require development of conventional and high-speed turbine, ramjet, scramjet, and combined cycle engines; high temperature materials; thermal protection systems (TPS); and thermal management systems.

The High Speed Systems Test (HSST) project addresses test technology needs including propulsion, aerodynamic and aerothermal testing, so the test community has the technology to support the required test scenarios for concepts under development in the science and technology (S&T) community. The technology developments within the HSST project align with the Department of Defense (DoD) S&T priority investments. As such, the HSST project is developing, validating and transitioning advanced test and evaluation (T&E) technologies for ground test, open-air range flight test, and advanced computational tools, along with instrumentation and diagnostics systems for use in both ground tests and flight tests of high speed systems.

The HSST project develops technologies to enable robust, accurate, and timely T&E of these future weapon systems. DoD acquisition regulations require weapon systems to undergo a thorough T&E process to detect deficiencies early and to ensure system suitability and survivability. However, the extreme environments in which these weapons operate preclude accurate determination of their performance and operability with today's T&E assets. Current national test capabilities have deficiencies in data accuracy, flight condition replication and simulation, test methods, productivity, modeling and simulation (M&S) fidelity, and range safety.

The HSST mission is to address these national test capability gaps by providing test technology solutions that will enable high-speed and hypersonic weapon systems to be successfully developed through accurate, robust, and efficient T&E.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High Speed Systems Test ***Description:*** The HSST project continued to advance ground and flight test technologies, techniques, instrumentation, and modeling and simulation capabilities required for the development of high speed air-breathing propulsion and boost-glide weapons. HSST continued progress toward addressing the two most significant technology shortfalls in current hypersonic aero propulsion ground test capabilities: clean air heat addition (i.e. non-vitiated air) and variable Mach number test capability. Current production ground test facilities create the high temperature propulsion system inlet conditions necessary for air-breathing scramjet engine testing by burning fuel in the facility airflow supplied to the engine inlet for operation. As demonstrated by a previous HSST test, the resulting vitiated air has different gas properties than clean air found in the atmosphere and thus is not representative of what the vehicle would experience during flight. This significantly affects the engine's performance and operability in the test environment resulting in erroneous flight performance predictions. In addition to the ability to test in clean air, a variable Mach number capability is required to "fly the mission" and determine the critical transient operability effects	32.074	17.930	15.185

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 091 / *High Speed Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
throughout the flight envelope. Incorporation of component technologies, previously developed by the T&E/S&T program, were integrated into a small-scale, clean air, true temperature, and variable Mach number (M4.5-7.5) aero propulsion test facility, called the Hypersonic Aerothermal and Propulsion Clean Air Testbed (HAPCAT). Completion of this facility will demonstrate that the component technologies and their integration have reached Technology Readiness Level (TRL) 6, provide an on-going test asset to the DoD, and reduce risk for construction of a full-scale facility. The HAPCAT project continued to develop and demonstrate air delivery system (ADS) technologies to provide uniform flow with variable pressure and temperature through a nozzle up to Mach 7.5 conditions. The project activities included the design and initial fabrication of the ADS and conceptual design of a full scale facility. Efforts continued on the morphing ceramic nozzle for hypersonic ground test facilities project which seeks to achieve a variable Mach number capability and variable inlet distortion patterns representative of flight-like inlet systems. Following validation testing conducted at the Air Force Research Lab (AFRL), efforts were made to begin the refurbishment of the nozzle for implementation into the HAPCAT facility. Construction of the Large Energy National Shock (LENS) Tunnel II extension was completed and evaluated to verify extended run times. Such testing will enable the full development of complex flow features affecting vehicle performance, the determination of control surface responsiveness and effectiveness, and the evaluation of the performance of aerodynamic features. The improvements will help fill a critical test capability gap and support future hypersonic vehicle programs. Initial facility performance assessments of the extended tunnel demonstrated a three-fold increase in test run time. The facility was successfully used by multiple customers who required the expanded capabilities in order to meet their test objectives. The HSST project continued development of a mid-pressure arc heater prototype. The prototype replaced an existing Huels arc heater with a segmented heater, creating a test envelope approximately three times larger than the current envelope for aerothermal testing. Validations runs were successfully completed confirming extended test run times of up to 30 minutes and a higher thermal load representative of that experienced by a hypersonic vehicle TPS. These efforts advanced progress toward the goal of improved T&E of maneuvering reentry and boost/glide vehicles. In a related effort, the arc heater flow quality aerothermal test technology development progressed toward independently-powered spin-coils to control the physical characteristics of the spinning arc column, its attachment location and duration on electrode surfaces within the arc heater. The effort investigated two different spin-coil designs, one of which was validated for use in the mid-pressure arc heater facility. This effort will improve the service life of the electrodes and improve nozzle flow quality. The HSST project continued research that will provide better prediction and determination of boundary layer growth and transition effects upon hypersonic vehicle performance. Understanding and predicting boundary layer transition represents a critical shortfall in the hypersonic community, as it affects the thermal loads, stability and control, and overall performance of a vehicle. Experimental results acquired through the boundary layer transition effort will be used to validate state of the art prediction tools and measurements of boundary layer transition mechanisms. Facility flow field characterizations were conducted at the Purdue quiet tunnel and the LENS facilities at CUBRC, enabling more effective comparisons between all the facilities and informing test customers of intrinsic flow features in each facility. The			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**

characterizations will also provide insight to boundary layer transition studies in these facilities. The project also conducted testing of a boost-glide vehicle, resulting in critical findings to support future flight tests of the vehicle.
HSST completed development of a ground based, portable high altitude light detection and ranging (LIDAR) system to measure atmospheric conditions (density, temperature, pressure, wind speed/direction, oxygen/water content) along a hypersonic vehicle's flight path. This technology is a significant advancement over current methods, which employ balloons carrying sensors to sample the atmosphere. The LIDAR will improve the accuracy of characterizing high altitude atmospheric conditions. This atmospheric data is needed to assess the performance and operability of air-breathing missiles and boost-glide vehicles during development. Testing and demonstration of LIDAR atmospheric sensing was completed and the portable system was transitioned to support test programs at coastal flight test ranges to demonstrate system performance in a maritime environment. Development of an airborne version of the LIDAR continued with the design and testing of hardware components for the in-flight demonstration of the system on a crewed aircraft in preparation for implementation on an uncrewed vehicle.
Progress continued on a high fidelity automated airborne reconfigurable tracking system which seeks to provide high resolution imaging of hypersonic vehicles in flight. The final design was completed including concepts for integration onto a Global Hawk aircraft.
The fabrication, and installation of a telemetry capability integrated with a High Altitude, Long Endurance Uncrewed Aerial System (HALE UAS) for a technical demonstration continued in preparation for support of flight testing.
Measurements of thermal emissions from the surface of typical boost-glide vehicles in an impulse test facility were conducted to evaluate the effectiveness of different surface compositions and treatments and filter frequencies for thermal imaging. The completion of this project resulted in valuable insights gained for a boost-glide vehicle design; these insights will be useful for future testing in high-enthalpy (high-energy) facilities.
Advances were achieved in the development of M&S tools. Verification and improvement of computational fluid dynamics (CFD) codes continued, making use of the unique data sets obtained from HSST scramjet engine tests and boundary layer experiments. A technical report was generated that summarizes the methodology for conducting boundary layer stability computations in support of acquisition programs, including shortfalls in current capabilities and recommended improvements for the toolsets available. This report was released to the hypersonic community and serves as a benchmark document for use in hypersonic programs.
The HSST transient thermal analysis software effort transitioned to users in the hypersonic community to support ground testing and flight testing.
A force measurement system technology development completed for use in short-duration, high-enthalpy test facilities. Such technology will permit testing that elucidates real gas effects on hypersonic vehicles.

FY 2018 Plans:
Continuing efforts will address: test technologies, techniques, and methodologies to determine full-scale propulsion system performance and operability from subscale tests. New initiatives will address technology for testing weather effects and further

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
development of M&S codes for accurate prediction of flow fields, boundary layer transition, and heat transfer in high-speed flow. Efforts will include demonstration of new flight test techniques, improvements in instrumentation, and continued improvement and validation of CFD codes. The HAPCAT clean-air, variable Mach number testbed will complete; this will include the design, fabrication, testing and installation of the ADS components. The ADS will combine three separate streams of pressurized air, each at different temperatures and pressures, and deliver them to the hypersonic nozzle of the HAPCAT facility. The air streams are regulated through the ADS to produce a specified flight enthalpy level appropriate for the clean air flight condition being simulated in the test. Upgrades to the LENS Tunnel to increase productivity and accuracy during operation will continue. Further validation of the spin-coil designs for the arc heater flow quality aerothermal test technology development will continue. Completion of boundary layer transition efforts will establish a new baseline protocol and recommendations for hypersonic aero performance predictions. Efforts will continue to assess the technical performance and CONOPS for a HALE UAS configured to support flight T&E of hypersonic vehicles. A telemetry system onboard a UAS capable of collecting data from a hypersonic flight vehicle over broad open ocean areas will be demonstrated. Efforts will continue to develop atmospheric sensing and optical imaging systems on uncrewed platforms to support flight tests. ***FY 2019 Plans:*** Developments will continue to improve hypersonic ground and flight test capabilities to levels required for acquisition programs. Efforts will include investigation of new flight test techniques to include further development and demonstration of a UAS-based range concept, investigation of new ground test instrumentation, and continued improvement and validation of CFD codes. The high fidelity automated airborne reconfigurable tracking system will be completed and demonstrated on a UAS, providing a new capability to support flight T&E of hypersonic vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	32.074	17.930	15.185

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 091 / *High Speed Systems Test*

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 092 / *Spectrum Efficient 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
092: *Spectrum Efficient Technology*	41.068	9.193	9.011	10.682	-	10.682	10.253	10.566	10.782	11.248	Continuing	Continuing

A. Mission Description and Budget Item Justification

Weapon systems have become increasingly complex in recent years, resulting in the need for significantly more data to be passed among these systems as well as between the systems and our test infrastructure. A vast amount of data must be collected, transmitted, and analyzed, which requires a large amount of radio frequency (RF) spectrum resources. However, the amount of RF spectrum designated to support test and evaluation (T&E) is decreasing, most notably due to reallocation of spectrum for commercial use. The combination of decreasing RF spectrum and increasing data requirements results in an urgent need to develop test technologies that maximize the use of spectrum resources for Department of Defense (DoD) T&E operations.

The L and S frequency bands are the traditional spectrum allotted for military T&E use. The explosive need for spectrum in the commercial sector has resulted in reallocation of portions of these bands to industry. To compensate, DoD is now authorized to use the C-Band spectrum which offers numerous benefits, including the potential for a large increase in available bandwidth, but the C-Band spectrum comes with technical challenges and regulatory constraints. Most notably, our current test infrastructure for telemetry is not designed to accommodate C-Band and the band is heavily shared for alternate uses. Technologies are required to implement innovative techniques that efficiently facilitate our use of C-Band without a major overhaul to our national test infrastructure. For instance, commercial telemetry transmitters operate in C-Band but do not have the form factor (size, weight and power) nor ruggedized packaging to survive airborne test applications.

Traditional telemetry applications employ streaming telemetry where data is moved one-way from the instrumented system under test to our test range infrastructure. Modern network based telemetry capabilities enable more robust, efficient bidirectional transfer of data. The DoD strategy is to create technologies for implementing a telemetry capability in C-Band, using the legacy L- and S-Bands for both streaming and networked telemetry, and researching the feasibility of using higher frequency bands to augment telemetry operations.

The Spectrum Efficient Technology (SET) project is developing test technologies that enable more efficient use of legacy telemetry bands and expansion into non-traditional areas of the RF and optical spectra at DoD test ranges. The technology development efforts within the SET project have been prioritized to align with Department of Defense guidance on science and technology priority investments. As such, the SET project is focusing on growing data requirements of warfighting systems and the limited availability of spectrum for testing. The SET project is structured to develop test technologies to advance range communications, networked telemetry capabilities, and enhanced management of spectrum at DoD test ranges.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Spectrum Efficient Technology	9.193	9.011	10.682
Description: The SET project performed risk reduction on a networked data recorder and data transmission scheme in support of Central Test and Evaluation Investment Program (CTEIP) networked telemetry projects. The networked data recorder addresses CTEIP requirements for data recording and parametric extraction during flight testing. The networked data recorder was used as the primary data recorder during CTEIP flight tests. The data transmission scheme is designed to minimize the amount and type of data transmitted over the telemetry network, reducing the amount of bandwidth consumed during a test event. This technology			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 092 / *Spectrum Efficient Technology*

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

enables more efficient use of the RF spectrum by reducing the amount of data transmitted by only transmitting data parameters when changes occur.
A non-blocking Ethernet switch for airborne applications was demonstrated showing 10 gigabit Ethernet data speeds required to support CTEIP data transmission requirements. Once ruggedized, this technology will serve as the network backbone which will tie all onboard instrumentation together with the onboard test data transmitter. SET matured technology to enable more efficient handling of multiple priority test data and communications between the network router and telemetry transceiver. Development continued on a multi-band transceiver operating in the L/S/C-Band spectrum employing multiple advanced waveforms. This technology determines the performance of the telemetry link and selects the optimal modulation scheme based on current link conditions, accounting for issues such as multipath. Technology enabling the compression of Pulse Code Modulation (PCM) data was further matured.
The SET project developed technologies to address over-the-horizon telemetry requirements to support the testing of large footprint, long range missiles and hypersonic weapons. An S-Band phased array antenna suitable for mounting on a Global Hawk platform was developed and its antenna gain performance characterized in a high fidelity laboratory environment. A modular digital beam-forming solution to control a phased array antenna and track multiple targets simultaneously was matured. These technologies will significantly reduce the system complexity for an airborne phased array antenna, providing savings in terms of size, weight, and power consumption.
The SET project initiated an effort to develop a software-based technology solution to accurately characterize RF spectrum utilization on DoD test ranges. This technology will develop the interfaces to existing range RF spectrum scheduling and resource management tools and also implement a standard set of spectrum usage metrics to quantify RF spectrum usage based on times of day and test programs. This tool will transition initially to the Air Force Test Center at Edwards AFB to support RF spectrum management activities, aid in the identification of future spectrum requirements, and quantify the impact of inadequate access to spectrum, in terms of program cost and schedule.

FY 2018 Plans:
The SET project will further advance development of technologies required for network telemetry. An L/S/C-Band transceiver will be transitioned to support both the CTEIP transceiver development and testing at the Edwards AFB RF Laboratory. The following will be transitioned to CTEIP projects: technology capable of reconfiguring the data modulation scheme based on telemetry link conditions, technology enabling more efficient handling of priority test data and communication between the network router and telemetry transceiver, technology enabling the dynamic reconfiguration of transmitted test data over a telemetry network, and an Ethernet switch for airborne applications. Technology enabling the compression of PCM data will be further matured. Efforts to develop spectrum management tools to optimize the use of available RF spectrum and accurately quantify RF spectrum usage on DoD test ranges will continue.
The SET project will transition technologies to address over-the-horizon telemetry requirements to support the testing of long range missiles including hypersonic weapons. An S-Band phased array antenna with a modular digital beam-forming controller

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 092 / *Spectrum Efficient Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
will be integrated into a Global Hawk and used to support over-the-horizon telemetry requirements for a Navy hypersonic flight test in CY 2017. The SET project will initiate development of a steerable, multi-band antenna for airborne platforms. This antenna technology will employ either mechanical or digital methods to point the telemetry link to a specific ground receive antenna. The pointing of the telemetry link will enable spectrum reuse through spatial diversity, enabling two test platforms to transmit test data within the same portion of RF spectrum. The SET project will initiate development of radio technology that can utilize alternate spectrum in the upper frequency bands. ***FY 2019 Plans:*** The SET project will further advance development of technologies required for network telemetry. Technology enabling the compression of PCM data will complete and transition to support aeronautical telemetry requirements at several test ranges including the Air Force Test Center and Army Redstone Test Center. Efforts to develop spectrum management tools to optimize the use of available RF spectrum and accurately quantify RF spectrum usage on DoD test ranges will continue. Efforts to develop phased array technology for use on the ground will continue. The development of a steerable, multi-band antenna for airborne platforms will continue. The development of radio technology that can utilize alternate spectrum in the upper frequency bands will continue. The SET project will initiate several efforts to develop the key technology components to use higher frequencies to support telemetry requirements. These efforts will focus on power amplifier, transmitter, and antenna development. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	9.193	9.011	10.682

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense												Date: February 2018
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603941D8Z / *Test and Evaluation/ Science and Technology*				Project (Number/Name) 093 / *Electronic Warfare Test*			
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**
093: *Electronic Warfare Test*	64.171	9.193	11.127	12.478	-	12.478	13.109	13.478	13.755	14.349	Continuing	Continuing

A. Mission Description and Budget Item Justification

In order to establish dominance in the modern battlespace, our offensive and defensive electronic warfare systems must be capable against advanced radio frequency (RF) directed threats and electro-optic (EO) guided threats, which include infrared (IR) guidance. Ensured dominance in these areas requires more robust test and evaluation (T&E) with technologies that are rapidly adaptable to changing threats.

Readily available, IR seeking, man-portable air defense systems (MANPADS) are difficult to detect and pose an imminent and lethal threat to military aircraft of all types. Our ability to counter such threats is essential to owning the battlespace in theater. Therefore, the ability to test missile warning systems (MWS), hostile fire indicator (HFI) systems, IR countermeasures (IRCM), and advanced threat sensors is critical to our national defense. Additionally, a new generation of enemy RF missile seekers is both currently fielded and in further development, requiring a correspondingly new generation of test technologies to test the latest countermeasures. The T&E community is required to test IRCM and RF countermeasure systems in a repeatable manner with ground-truth data before and after integration into warfighting systems. Without new test technologies, the Department of Defense (DoD) will be unable to perform adequate T&E of advanced warning and countermeasure systems.

The technology development efforts within the Electronic Warfare Test (EWT) project have been prioritized to align with DoD guidance on science and technology priority investments. As such, the EWT project is focusing on the test needs in both the EO, including IR, and the RF threat domains. Additionally, development of core test technologies in this area can be leveraged to meet other EO and RF test requirements, such as in fire control systems; intelligence, surveillance and reconnaissance (ISR) sensors, and weapon seekers.

The EWT project develops test technologies to stimulate IRCM and RF system sensors through the high-fidelity simulation of scenes viewed by the sensors. Stimulation can be as simple as testing to see if a system under test responds to an image or as complex as simulating complex battle space phenomena to measure the response of a system under test in a more relevant, cluttered scenario. Simulations and stimulations are used at open air ranges and in installed system test facilities (ISTF), and in hardware-in-the-loop (HWIL) test beds.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Electronic Warfare Test ***Description:*** The prototype multi-static radar for testing of HFI systems completed. EWT continued to develop high fidelity scene generation technology for both EO and RF environments. EWT completed a wideband multi-beam klystron transmitter for high fidelity threat simulation of next generation RF surface-to-air missiles to include demonstration and transition to a test range. Development of Digital RF Memory (DRFM) algorithms for generation of virtual radar targets was completed. Work was completed on using DRFMs to enable chamber testing of data link communications between aircraft; the technology transitioned to Navy facilities. Development of synthetic aperture radar scene projection continued. ***FY 2018 Plans:*** The EWT project will invest in new technologies related to improving the electronic warfare T&E infrastructure. These new technologies will address the requirements to test and evaluate emerging weapon seekers, ISR sensors and next generation	9.193	11.127	12.478

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 093 / *Electronic Warfare Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
IRCM and RF EW systems. These investments will include high apparent temperature IR scene projectors at high frame rates and large formats to support testing of emerging sensors. RF scene generation to support EW systems testing will be developed. High power two-color emitters for open air testing of EO/IR sensors will be investigated. A plane-wave generator for representing RF threats inside an ISTF will be investigated. ***FY 2019 Plans:*** The EWT project will continue prior year efforts to improve the electronic warfare T&E infrastructure. Technologies to support adaptive EW testing will be investigated. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	9.193	11.127	12.478

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 094 / *Advanced Instrumentation Systems 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
094: *Advanced Instrumentation Systems Technology*	49.168	4.883	10.004	11.517	-	11.517	12.524	12.886	13.150	13.718	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Advanced Instrumentation Systems Technology (AIST) project addresses the test technology gaps resulting from emerging weapon systems that need to be tested at Department of Defense (DoD) open air ranges, undersea ranges, installed systems test facilities, hardware-in-the-loop laboratories, and measurement test facilities. Instrumentation requirements for systems under test are increasing exponentially for new weapons systems. Vehicle-borne and warfighter-wearable instrumentation packages are required. This instrumentation is for sensing and collecting critical performance data; determining accurate time, space, position information (TSPI)and attitude information; interfacing with command and control data links; monitoring and reporting system-wide communications; recording human operator physical and cognitive performance; and storing and transmitting data.

The technology development efforts within the AIST project have been prioritized to align with DoD guidance on science and technology (S&T) communities of interest (COIs). The AIST project is focused on supporting technology developments for advanced TSPI instrumentation (especially with limited or no availability of the Global Positioning System (GPS)), advanced sensors, advanced energy and power systems for instrumentation, non-intrusive instrumentation, mitigating range encroachment issues, and measuring warfighter physical and cognitive performance.

The AIST project addresses requirements for miniaturized, non-intrusive instrumentation suites with increased survivability in harsh environments. Such instrumentation is an urgent need because minimal space is available to add instrumentation to new or existing weapon systems subsequent to their development; furthermore, additional weight and power from instrumentation can adversely affect weapon system signature and performance. Instrumentation for humans-in-the-loop, such as dismounted warfighters, must not adversely affect performance, induce artificiality in the test environment, nor create operational burden. New technologies can be exploited to integrate small, non-intrusive instrumentation into emerging platforms during design and development, and, in some cases, into existing platforms. This class of instrumentation will provide critical system performance data during test and continuous assessment throughout a system’s lifecycle. Technology developed under AIST can also benefit training and combat missions by enabling a continual feedback loop between the developer, training staff, operators and commanders.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Instrumentation Systems Technology ***Description:*** Major thrusts included continuing efforts in advanced sensors, TSPI instrumentation, warfighter physical and cognitive assessment under various workloads and mitigation of test range encroachments. The AIST project completed development of advanced waveforms to mitigate wind turbine effects on DoD test ranges. Development continued on a passive imaging technology to derive size, shape, mass, drag coefficients, velocity and vectors for individual fragments to quickly characterize the fragment characteristics and distribution in warhead testing. Work completed on classifiers to identify specific sea mammals (e.g., various dolphin and whale species) found at undersea ranges and the automated processing and display of mammal detections. The AIST project continued the development of: a system to measure and assess warfighter cognitive performance under realistic conditions during a T&E event; a personnel	4.883	10.004	11.517

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 094 / *Advanced Instrumentation Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
tracking system using amplitude modulation (AM) band signals; and technology to evaluate back face deformation of body armor from a blunt trauma event. Work completed on a technology for in-water vehicles to recognize their position relative to another in-water platform in real time. This will improve safety during tests and allow for more controlled two-body T&E events involving conventional sea platforms as well as autonomous underwater vehicles. This technology transitioned to the U.S. Navy. The AIST project initiated an effort to develop a high fidelity model which takes into account the noisier acoustic properties of shallow water environments (120 feet to 900 feet) for littoral T&E. The model will support evaluation of undersea test range technologies (e.g., hydrophone arrays, new communication signals/modulations, transducers, and portable instrumentation. ***FY 2018 Plans:*** Efforts will include development of advanced TSPI technologies for non-intrusive applications using wireless systems and optical, infrared, and/or acoustic techniques. TSPI technologies will be further developed to support: data collection in GPS-denied environments with a focus toward data fusion from disparate sensors, TSPI on high dynamic systems such as missiles and projectiles, and real time casualty assessment. Advanced sensor initiatives for non-intrusive applications will include multimodal transducers, and self-registering/self-calibrating sensors. Sensing applications will include weapon system orientation, body armor blunt trauma evaluation, air launched stores separation, and weapon angle of incidence measurement at impact. Advanced data transformation initiatives will develop technologies for adaptive computing, virtual/synthetic instrumentation, data compression, wireless on-board data transport and improved data storage density. Other areas of investigation will include micro-miniaturization of electronic components for non-intrusive applications. AIST will continue to investigate technologies for mitigating range environmental encroachment issues such as alternative energy interference with range tracking systems. Additional efforts will include human performance measurement and assessment, specifically human interaction with unmanned systems and the evaluation of the interaction of the warfighter and weapons/equipment and interactions between individual warfighters in team-based holistic assessments. The AIST project will complete technologies to measure: fragment characteristics from warhead testing; TSPI using distinctive near-field patterns from AM signals; and mental load of warfighters during test events. ***FY 2019 Plans:*** The AIST project will initiate development of: sensors to support advanced hypervelocity projectile testing; non-destructive weapons testing (such as non-destructive radiographic defect evaluation for warheads and other weapons structures); energy and power for rapidly deployable sea ranges; advanced non-intrusive data management techniques; and mitigation technologies for monitoring effects from electromagnetic interference from solar power towers. The AIST project will complete fiber optic shape sensing technology that accurately provides dynamic measurements during the time history of back face deformation of body			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 094 / *Advanced Instrumentation Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
armor from a blunt trauma event. AIST will complete development of a high fidelity model for assessing technologies used in an undersea littoral test range. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	4.883	10.004	11.517

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 095 / *Directed Energy Test*

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
095: *Directed Energy Test*	41.779	7.362	7.259	8.654	-	8.654	8.593	8.853	9.034	9.424	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) is exploring the military utility, safety, and suitability of directed energy weapons. A robust test capability to assess directed energy weapons is essential to understanding their effectiveness and limitations, including determining their effectiveness in performing counter improvised explosive device (C-IED) operations. Such assessments will depend upon knowledge acquired through the test and evaluation (T&E) of directed energy technologies and testing of operational concepts. Directed energy weapon technologies, primarily consisting of high energy lasers (HEL) and high powered microwaves (HPM), are outpacing available test capabilities. Traditional test techniques for evaluating conventional munitions (with flight times ranging from seconds to minutes) are not sufficient for the T&E of directed energy weapons that place energy on target instantaneously. Consequently, new test technology solutions are needed to ensure that adequate developmental, live-fire, and operational test capabilities are available when directed energy programs are ready to test.

Directed energy system and component testing requires three principal assessments: (1) energy or power on target; (2) the effects on the target; and (3) the propagation of the directed energy to the target through the atmosphere. In addition, the vulnerabilities of DoD systems to directed energy threats are required to be characterized, such as those requirements captured in Military Standard (MIL-STD)-464C. Equally as important, current test capabilities do not provide the detailed data required to understand U.S. directed energy system performance and effects. The technology development efforts within the Directed Energy Test (DET) project have been prioritized to align with DoD guidance on science and technology priority investments. As such, the DET project is developing the technologies necessary for quantitative assessment of United States (U.S.) HEL and HPM performance, as well as the vulnerability of DoD weapon systems to enemy directed energy threats.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Directed Energy Test	7.362	7.259	8.654
Description: DET continued efforts to measure HEL energy on small targets such as mortars. The effort is designing a recoverable mortar prototype to address Army and Navy requirements and an Air Force requirement for a missile-mounted target board. Work completed on a Light Detection and Ranging (LIDAR)-based technology to characterize atmospheric profiles along a slant path adjacent to the HEL beam propagation path in a maritime environment. This technology enables real-time determination of the maritime atmospheric aerosol extinction profile from coastal land or a moving ship. Development of non-intrusive dielectric voltage probes capable of measuring high voltage pulses and potentials completed. This technology will support measurements during HPM engagements including testing of electrical static discharge weapons used for C-IED applications. Efforts continued to mature a dense plasma focus technology to produce strategically relevant, ultra-short pulse neutron fluence levels for nuclear vulnerability testing. This project successfully demonstrated neutron production. These efforts were reducing risk for the Central Test and Evaluation Investment Program Pulsed Neutron Environment project. ***FY 2018 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 095 / *Directed Energy Test*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Efforts will continue to focus on technology developments for onboard measurement of energy on target and characterizing effects on small targets, such as mortars and rockets. The DET project will continue development of surrogate HPM sources to address gaps in MIL-STD-464C testing and instrumentation to support Joint technology demonstration programs. The effort to mature the dense plasma focus technology for an ultra-short pulse neutron source to support nuclear vulnerability testing will continue. ***FY 2019 Plans:*** Investments in HEL test technologies will be initiated to assess the changes in HEL effects due to the shift of HELs to shorter wavelengths near one micron. These technology developments will include efforts to characterize the performance of HEL systems as they engage small targets such as enemy rockets, missiles, artillery, and unmanned aerial vehicles. In the HPM area, measuring the actual cause of HPM effects on electronics will be addressed by measurement of electrical currents within the wires and chips of the electronic targets. DET will continue to investigate new technologies to further address gaps in the availability of sources for MIL-STD-464C testing. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	7.362	7.259	8.654

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 096 / *C4I & Software Intensive Systems Test*

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
096: *C4I & Software Intensive Systems Test*	82.136	12.379	15.707	12.381	-	12.381	11.075	11.420	11.654	12.158	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Command, Control, Communications and Intelligence (C4I) and Software Intensive Systems (SIS) Test (C4T) project is pursuing technologies to emulate Net-Centric Military Operations in a System of Systems (SoS) test environment. Likewise, C4T is developing technologies to analyze the increasing mass of structured and unstructured data generated by C4I and SIS testing. The technologies are required when testing sensor platforms, command and control systems and weapon platforms that support the kill chain in a Joint operation. These systems must be evaluated for their ability to provide the accurate, timely transfer of data (e.g., target tracks, weapons allocation, mission tasking, and situational awareness) as the data passes among the Services and coalition participants.

The technologies within C4T will remove undesired distributed testing biases while improving test agility and the tester's ability to effectively conduct rapid analysis of "Big Data" and automated test reporting. C4T advances test automation features (test planning, test execution, Big Data collection, analysis, and visualization) that enable the virtual integration of Department of Defense (DoD) weapon laboratories and open air ranges. Using modeling and simulation (M&S) along with hardware-in-the-loop (HWIL)laboratories, the effectiveness of Joint missions can be assessed in terms of system-of-systems interoperability and effectiveness in executing Joint mission operations, including testing of weapons and command and control systems accessing and providing information.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: C4I and Software Intensive Systems Test ***Description:*** The C4T project completed development of technologies to enable the Test and Training Enabling Architecture (TENA) to utilize remote methods of authentication and privilege management to distributed users. Moreover, these technologies will support the use of TENA over a broad range of networks and provide a common interoperability test architecture. C4T continued development of technologies in multiple areas of "Big Data" rapid analytics by focusing on facilitating Data-to-Decisions (D2D). These technologies contribute to knowledge management and analytics in support of near-real time semantic analysis of large structured and unstructured datasets and assist the analyst in making decisions during test events. These technologies are targeted for support of F-35 testing. C4T continued to develop real-time automated multi-band infrared target segmentation technology using state-of-the-art neural network and deep learning based algorithms. Development continued on technologies to test MK-48 and MK-54 torpedoes. These technologies will provide an acoustic propagation model, both narrow and broad band, of sufficient fidelity to test torpedo performance in various maritime tactical environments. The model includes a real-time simulation/emulation system for testing torpedo sonar systems in multiple bathometry, biological and threat environments. The model will incorporate autonomous evasion maneuvers of targeted submarines or surface ships.	12.379	15.707	12.381

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 096 / *C4I & Software Intensive Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The C4T project continued the development of technologies to provide a reliable, fast, and cost-effective approach that enables Live Virtual Constructive (LVC) testing of next generation weapon systems. These technologies will enable live assets to sense and respond to stimulus without regard to whether the stimulus is real or synthetic. The C4T project initiated the development of technologies to optimize the deployment of test support networks, plan expeditionary tests, manage bandwidth and spectrum contention with a networked system under test, and provide Real-Time Casualty Assessment (RTCA) data during live tests. These technologies will address deficiencies in Operational Test (OT) for network-enabled technology. ***FY 2018 Plans:*** C4T will investigate modeling and simulation (M&S) technologies to support emulation and stimulation of networks for conducting T&E. Development will continue on the verification and validation (V&V) of the M&S test environment across battlespace environments in support of both developmental test (DT) and OT. C4T will continue to develop representations of systems, communications and environments with the necessary fidelity and run-time performance crucial for the successful testing at HWIL laboratories, installed system test facilities, and open air ranges. The development of LVC technologies in support of T&E of 5th generation aircraft will also continue. Technology developments will focus on semantic analysis of large structured and unstructured data sets. These technology developments will include the ability to process unstructured test data into a structured format for analysis using D2D algorithms. Further work on the correlation and analysis of “Big Data” from multiple sources will continue. Development of techniques to automate the reuse of knowledge to enable continuous DT throughout the lifecycle of weapon systems will continue. Additional investments will be targeted at assessing warfighter systems that in themselves implement D2D, “Big Data”, and deep learning technologies. The C4T project will continue to develop technologies that mitigate data biases introduced by the test infrastructure. Development will continue on LVC technologies for testing C4I systems within a synthetic battlespace environment to augment open-air ranges with vast simulated areas and dense communications environments. Multi-Level Security (MLS) and Cross Domain Solution (CDS) technologies will be investigated with the goals of improving the automation of preparing test data for analysis as well as facilitating automated sharing of information across all security enclaves. ***FY 2019 Plans:*** Work started in FY 2018 will continue. The C4T project will invest in developing MLS and CDS technologies and assessing DoD platforms employing “Big Data” techniques with a specific focus on tactical fighters in a net-enabled, dynamic environment. Developments will include V&V across integration and aggregation techniques for SoS evaluation as well as automating testing of warfighter SIS using virtualized and cloud environments.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 096 / *C4I & Software Intensive Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
"Big Data" analytical tools will continue to be developed to automatically analyze, extract, and manage meaningful patterns, trends and information from terabytes of structured and unstructured test data. Transition of these technologies for F-35 testing will commence. The C4T project will invest in developing technologies to improve M&S fidelity, run-time performance and the realistic representation of systems, sensors, communications and environments in support of T&E. Investments will also be made in technologies for: testing warfighter systems employing agile communications, effectiveness evaluation in a mission context, analytics for database intensive warfighter systems, automated test planning, the design of experiments, machine cognitive analysis, and testing human-computer interactions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program Adjustments			
Accomplishments/Planned Programs Subtotals	12.379	15.707	12.381

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 097 / *Unmanned and Autonomous System Test*

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
097: *Unmanned and Autonomous System Test*	23.314	10.316	11.168	14.490	-	14.490	13.692	13.105	13.374	13.952	Continuing	Continuing

A. Mission Description and Budget Item Justification

Unmanned and Autonomous Systems (UAS) support every domain of warfare. They operate in space, in air, on land, on the sea surface, undersea and in subterranean conditions to support a vast variety of missions. The emergence of unmanned systems brings a host of revolutionary capabilities that will profoundly influence warfare. The Unmanned and Autonomous Systems Test (UAST) project addresses current and emerging challenges associated with the test and evaluation (T&E) of these critical warfighting capabilities. The technology developments within the UAST portfolio have been prioritized to align with Department of Defense (DoD) guidance on science and technology priority investments, particularly in assessing autonomy. As such, the UAST project is developing test technologies to simulate, stimulate, instrument, measure, and assess an autonomous system's ability to perceive its environment, process information, adapt to dynamic conditions, make decisions, and effectively act on those decisions in the context of mission execution.

The UAST project will provide the test technologies to effectively measure performance and characterize risk, thereby increasing warfighter trust in autonomous systems. Current DoD test capabilities and methodologies are insufficient to address the testing of increasingly autonomous units and teams of unmanned systems operating in unstructured, dynamic, battlespace environments. Furthermore, advancements are being made in developing collaborating, system-of-autonomous-systems that will work in concert as a swarm or pack and in close proximity with humans. New test technologies are needed to stress the collective set of autonomous systems under realistic conditions, predict emergent behavior of autonomous systems, emulate the complex environment, and assess mission performance of these highly coupled and intelligent systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Unmanned and Autonomous System Test ***Description:*** New efforts focused on test technologies supporting the near term challenges identified in the 2013–2038 DoD Unmanned Systems Integrated Roadmap, such as, integrating DoD unmanned systems within the National Airspace and safely operating unmanned aerial systems within the Major Range and Test Facility Bases (MRTFB). UAST collaborated with the Autonomy Community of Interest (COI) Test and Evaluation, Verification and Validation Working Group to ensure that UAST is investing in technologies relevant to the future of autonomous systems. The UAST project explored technologies required for T&E of emerging UAS architectures, functional components, and interfaces. The UAST project emphasized autonomy test technologies that can be integrated for use in a Test and Training Enabling Architecture (TENA) environment within the MRTFB. UAST continued investments in robustness testing technology to detect and predict vulnerabilities and failures within UAS software. UAST continued developments to automatically predict test vehicle collision potentials and cue test range controllers to take corrective action. These technologies will also prevent the test vehicle from violating flight envelopes, range boundaries, and warning areas. UAST initiated an effort to develop a software tool that will enable testers to monitor the internal autonomous processing states of a system under test without interfering with its operations	10.316	11.168	14.490

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 097 / *Unmanned and Autonomous System Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
or requiring modification to the system's software or hardware. UAST initiated efforts to produce a comprehensive and actionable Strategic Autonomy T&E Investment Plan by assessing autonomy test infrastructure gaps, and evaluating test technology maturity required to cover gaps. ***FY 2018 Plans:*** Development of technologies that rapidly develop test plans, assess regression testing required, and characterize the bias from the test environment and instrumentation will complete. The technologies will be fully compliant with TENA and suitable for integration on the Joint Mission Environment Test Capability network. The UAST project will continue to develop test technologies that address mid-term UAS test challenges associated with autonomy and initiate efforts to explore the far term challenges of testing system intelligence. These efforts will include research on test technologies to measure the logical flow of sensing data to perception, decisions, and action. The UAST project will invest in complementary tools to predict UAS behavior by monitoring how autonomous systems process data in response to environmental changes. The UAST project will investigate technologies for T&E of UAS-to-UAS and human-to-UAS interactions. The UAST project will complete the development of technologies to automatically predict test vehicle collision potentials and cue test range controllers to take corrective action. These technologies will be TENA compliant to facilitate transition across the MRTFB. The UAST project will complete the development of the Strategic Autonomy T&E Investment Plan. The UAST project will complete research on autonomous system test planning technology which will identify the most pertinent test plans for maritime, air, and ground-based autonomous systems, enabling testers to identify the degree of regression testing required for autonomous systems upon changes to hardware and/or software. UAST will continue coordination with the Autonomy COI and relevant Service organizations to improve T&E of autonomous systems. ***FY 2019 Plans:*** The UAST project will continue to initiate and develop technologies to support autonomous system test planning, autonomous system test execution, and autonomous system performance assessment. Efforts within test planning will include predicting autonomous behavior for testing and assuring thorough testing of autonomous systems. Investments in test execution will include: enhancing safety of autonomous system testing; creating test environments that are complex, immersive, and reactive; and adapting ranges to cognitive, autonomous system testing. Developments under performance assessment will include: testing and evaluating UAS-to-UAS and human-to-UAS interactions and measuring autonomous system reliability. The UAST project will complete development of technologies that automatically learn conditions for activating vulnerabilities deep within an autonomous system, using machine learning and backward chaining techniques to determine system level inputs that induce failure. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 097 / *Unmanned and Autonomous System Test*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Program Adjustments			
Accomplishments/Planned Programs Subtotals	10.316	11.168	14.490

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 098 / *Cyberspace Test*

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
098: *Cyberspace Test*	17.456	4.205	7.380	11.002	-	11.002	12.988	13.314	13.587	14.174	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) ability to use cyberspace for rapid communication and information sharing in support of operations is a critical enabler of DoD military missions. Advancements in utilizing cyberspace are outpacing the technologies needed for test and evaluation (T&E). The Cyberspace Test Technology (CTT) project develops advanced technologies and methodologies to test and evaluate DoD capabilities and information networks to defend and conduct full-spectrum military operations across cyberspace. Current cyberspace T&E capabilities are insufficient to support the continual experimental, contractor, developmental, operational, and live-fire testing requirements of warfighter systems operating in cyberspace. Many of the test tools and infrastructure items required for systems in cyberspace will require advancement and maturation of nascent test technologies. The CTT project will address test technology shortfalls in cyberspace testing, including planning cyberspace tests, creating representative cyberspace threats and test environments, executing cyberspace tests, and performing cyberspace test analysis and evaluation.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Cyberspace Test	4.205	7.380	11.002
Description: Completed development of an automated sanitization framework with assured capability for verifying sanitization of cyber range components; this is important because it allows the reuse of limited assets for successive T&E events. This technology transitioned to the National Cyber Range and other cyberspace test organizations. The CTT project continued development of technologies to detect, monitor, and analyze malware behavior during cyber-attacks in a virtualized T&E environment. CTT continued development of tools to measure, classify, and emulate cyberspace threat actors for T&E. ***FY 2018 Plans:*** The CTT project will pursue technology developments addressing needs to: provide automated cyberspace test planning, create representative cyberspace threats and test environments, execute cyberspace tests, and perform cyberspace test analysis and evaluation. These efforts will support: defensive and offensive cyberspace weapon systems testing; the testing of datalinks; the testing of enterprise information systems; and testing of cyber resiliency of air, land, and sea-based weapon systems. CTT will continue to develop a system capable of detecting, monitoring, and analyzing malicious behavior during cyberspace attacks. ***FY 2019 Plans:*** The CTT project will pursue technology developments addressing needs to: provide automated cyberspace test planning, create representative cyberspace threats and test environments, execute cyberspace tests, and perform cyberspace test analysis. These efforts will support defensive and offensive cyberspace weapon systems testing, as well as cyber resiliency testing of air, land, and sea-based weapon systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603941D8Z / *Test and Evaluation/ Science and Technology*	**Project (Number/Name)** 098 / *Cyberspace Test*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Program Adjustments			
Accomplishments/Planned Programs Subtotals	4.205	7.380	11.002

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*

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	224.936	41.459	38.403	40.582	-	40.582	40.652	41.387	42.032	42.803	Continuing	Continuing
455: *Operational Energy Capability Improvement*	206.773	41.459	38.403	40.582	-	40.582	40.652	41.387	42.032	42.803	Continuing	Continuing
456: *Hybrid Energy Storage Module (HESM)*	18.163	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

Note

None

A. Mission Description and Budget Item Justification

The basic mission of this program element is to fund innovation to improve the Department of Defense’s (DoD) operational effectiveness via targeted operational energy science and technology (S&T) investments. It contains the two projects described below:

P455, the Operational Energy Capability Improvement Fund (OECIF), incentivizes S&T to promote long term change in DoD capabilities so they are better aligned with the Operational Energy Strategy. OECIF generally fosters innovation to improve operational energy performance and has two key mission aspects. First, to develop operational energy technologies and practices that will improve DoD military capabilities and possibly reduce costs. Second, to establish within the military Services institutional momentum to continue those innovations. OECIF funds serve as “seed money” to start or consolidate promising operational energy innovation to be sustained by the Services; accordingly, OECIF generally emphasizes supporting or establishing programs, rather than one-off projects.

P456, the Hybrid Energy Storage Module (HESM), co-sponsored by the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) and the Assistant Secretary of Defense for Energy, Installations and Environment (ASD(EIE)), develops advanced energy storage technologies to maximize performance and reliability, and enable future high power weapons and sensor systems on legacy and next generation vehicles, aircraft and ships. The goals of HESM are to (1) demonstrate energy storage systems with high power/energy densities, scalable to all power levels, that reduce total logistics demand, (2) increase platform ability to sustain operations during engagement, and (3) reduce maintenance. Once demonstration is complete, this technology will be sustained by the Services and will be used to extend the operational performance and safety for these applications beyond the hybrid storage module baseline design configuration. This program is closely coordinated with the Advanced Management and Protection of Energy-storage Devices (AMPED) program of the Department of Energy's (DOE) Advanced Research Projects Agency - Energy (ARPA-E).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	37.329	38.403	40.914	-	40.914
Current President's Budget	41.459	38.403	40.582	-	40.582
Total Adjustments	4.130	0.000	-0.332	-	-0.332
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	5.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.823	-			
• FFRDC Transfer	-0.047	-	-	-	-
• Economic Adjustment	-	-	-0.332	-	-0.332

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

	FY 2017	**FY 2018**
Project: 455: *Operational Energy Capability Improvement*		
Congressional Add: *OECI*	4.953	0.000
Congressional Add Subtotals for Project: 455	4.953	0.000
Congressional Add Totals for all Projects	4.953	0.000

Change Summary Explanation

Economic adjustment directed for FY19 (EA-008 budget decision).

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*	

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
455: *Operational Energy Capability Improvement*	206.773	41.459	38.403	40.582	-	40.582	40.652	41.387	42.032	42.803	Continuing	Continuing

Note

P455, the Operational Energy Capability Improvement Fund (OECIF), incentivizes S&T to promote long term change in DoD capabilities so they are better aligned with the Operational Energy Strategy. OECIF generally fosters innovation to improve operational energy performance and has two key mission aspects. First, to develop operational energy technologies and practices that will improve DoD military capabilities and possibly reduce costs. Second, to establish within the military Services institutional momentum to continue those innovations. OECIF funds serve as “seed money” to start or consolidate promising operational energy innovation to be sustained by the Services; accordingly, OECIF generally emphasizes supporting or establishing programs, rather than one-off projects.

A. Mission Description and Budget Item Justification

The basic mission of this program element is to fund innovation to improve the Department of Defense’s (DoD) operational effectiveness via targeted operational energy science and technology (S&T) investments.

P455, the Operational Energy Capability Improvement Fund (OECIF), incentivizes S&T to promote long term change in DoD capabilities so they are better aligned with the Operational Energy Strategy. OECIF generally fosters innovation to improve operational energy performance and has two key mission aspects. First, to develop operational energy technologies and practices that will improve DoD military capabilities and possibly reduce costs. Second, to establish within the military Services institutional momentum to continue those innovations. OECIF funds serve as “seed money” to start or consolidate promising operational energy innovation to be sustained by the Services; accordingly, OECIF generally emphasizes supporting or establishing programs, rather than one-off projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Operational Energy Capability Improvement Fund ***Description:*** The basic mission of the OECIF is to fund innovation that will improve DoD operational effectiveness via targeted S&T investments. As Defense-Wide funding, it incentivizes S&T to promote long term change in DoD capabilities so they are better aligned with the Operational Energy Strategy. OECIF generally fosters innovation to improve operational energy performance and has two key mission aspects. First, to develop operational energy technologies and practices that will improve DoD military capabilities and possibly reduce costs. Second, to establish within the military Services institutional momentum to continue those innovations. OECIF funds serve as “seed money” to start or consolidate promising operational energy innovations to be sustained by the Services; accordingly, OECIF generally emphasizes supporting or establishing programs, rather than one-off projects. ***FY 2018 Plans:***	36.506	38.403	40.582

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
The TMSC program, which began in FY13, will still be active. TMSC will incorporate DoD and Service comments and publish the final draft for DoD approval. J-DEPLOI, which began in FY14, will still be active. J-DEPLOI plans to complete software development and testing, MBPS integration, and plan transition of the program to MPBS management and PACOM users. The FY15 vehicles program will continue. The Thermally Efficient Cylinders program will test the single-cylinder engine with an optimized coating and piston and will begin laboratory preparations for multi-cylinder testing. The TVEK program will complete the SIL testing with all sub-systems integrated into the vehicle, evaluate the sub-system fuel savings and M&S results from the Matlab Simulink and the Army Joint Operational Energy Initiative (JOEI) model to determine optimal kit architecture, start integration of kits in the HEMTT and LVSR vehicles, initiate electromagnetic interference testing of sub-systems, and develop vehicle test plans and agreements with testing facilities. The Automation/Smart Cruise Control program will complete Phase II by conducting convoy testing, deliver a final report, and provide the developed technology. The M&S for Light-Weighting program will incorporate novel materials for analysis and compare with the baseline system model. The FY16 unmanned vehicles programs will continue. The Reliable, Efficient, Tactical UAS Power System program will test the second generation engine for power output, specific fuel consumption, altitude, and product reliability. The Hybrid Tiger team will begin the flight testing phase validating the performance models and tuning flight controller gains, and refine software to emphasize optimal hybrid mode transitions and increased autonomy for soaring. The HTVE-UE program will continue base tasks related to component fabrication and breadboard assembly and testing, execute at-sea test planning, and perform initial system deployment; and continue studies and analyses related to FDECO interoperability, HTV characterization/ environmental considerations, and CONOPS. The Aluminum Seawater Power program will go through the next round of component development and testing, and begin integration testing. The Small Turboprop Engine Range/Power Enhancement program will begin engine detailed design and acquire long lead materials for engine fabrication. The JP-8 Based Fuel Cell Power program will conduct physical integration of the JP-8 reformer and solid oxide fuel cell and all supporting hardware, and conduct the first two iterations of system level testing to determine weak parts of the system design. The programs begun in FY17 will continue to ramp up during this fiscal year. New programs will start in FY18. The focus of these new programs is likely to reflect input from the Services, various research Communities of Interest within DoD, such as Energy and Power, Ground and Sea Platforms, and Air Platforms, and any developing gaps or opportunities identified by ODASD(OE). ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The FY 2016 programs will reach their final year of OECIF funding. The IPTE program will complete detailed design, initiate hardware manufacturing for the engine demonstrators, and complete a combustor rig test. The Hybrid Tiger program will integrate energy and software systems to enable 24 hour and max endurance (100+ hour) demonstration flights; document performance, technical details, additional results, and paths forward; establish notional payload integration to determine mission utility and highlight transition path. The Aluminum Seawater Power program will go through breadboard hot-component test readiness review and testing and complete the breadboard full-system test readiness review and testing. The HTVE-UE program will conclude the at-sea testing, retrieve the device and analyze results while completing CONOPS and other studies and analyses as part of planning for transfer to other Navy S&T programs, which can further develop the technology for potential use by programs of record. The JP-8 Based Fuel Cell Power program will conduct the third iteration of the system integration with finalized control strategy and balance plant hardware and begin preparations on the vehicle for installation. The FY 2017 programs will continue. The OSCIPPT team will complete the second major release of the subsystem controls, the interface description document, and coordination control for the physical architecture defined in FY 2017; demonstrate fuel savings improvements on aircraft and ship platforms; and demonstrate improved response times within the power and thermal systems enabling use of future high power sensors and weapons on aircraft. The TEAPPS team will complete testing and modeling the first prototype thermal management system, design a sub-scale diode thermal management device with phase change materials, and identify the interfaces necessary to integrate an advanced thermal management system onto a Naval surface combatant. The PTROL team will further build upon the technology to apply laser power beaming to power remotely a rotary wing unmanned air vehicle at greater range than in previous demonstrations as an interim step towards a broadly-applicable and transition-able final capability to be delivered in FY 2021. The W-Band Power Beaming team will integrate the millimeter wave absorber and heat transfer assembly with the heat pipe and Stirling engine; perform short-range power beaming testing; transfer millimeter wave power from the gyrotron enclosure to the laboratory enclosure via existing waveguide hardware and beamed at the absorber using a short-range horn and mirror array. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY18-FY19 Increase in funding ($2.179) Two of the FY17 congressional add programs are able to continue. Space Solar and HD HESM. SSP will fabricate and demonstrate the Rectenna Array (diodes and manifolded antenna) - the goal is to show energy harvesting with a 1 uW per square cm incipient radio frequency. Additionally, teaming with NASA for prior S&T investment capture and work with NREL on space solar cells will continue. HD HESM will execute hardware fabrication and assembly, complete initial factory acceptance testing, initiate HESM Test Program at the Air Force Research Lab, the Army Tank Automotive Research, Development and Engineering Center, and perform Navy platform analysis.			
Accomplishments/Planned Programs Subtotals	36.506	38.403	40.582

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*

	FY 2017	FY 2018
Congressional Add: OECI	4.953	0.000

FY 2017 Accomplishments: The Joint Operational Command and Control effort demonstrated the ability to pass operational energy information around the battlefield. Initial results show the ability to manually capture some limited operational energy information and provided it to decision makers within 24 hours of data capture. The team conducted a design update for the Asset Wireless Network (AWN) Common Communications Module, installed firmware updates and executed a contract with Penn State University for AWN support

Operational Energy Watson was able to demonstrate a minimum viable product centered on AF S&T investment in Hypersonics and specifically in high-temperature materials. OE Watson is developing a cognitive assistant that combines deep learning, quantitative analysis, and analytic wargames. Funding also allowed for adoption of a single knowledge management tool(SEMS2.0) re-purposing from SERDP/ESTCP to OECIF. The tool has been adapted for OECIF and the FY18 call of proposals and selection is utilizing this new capability.

Space Solar Power team held the program kickoff, discussed the application for potential users, and defined metrics of success. Initial focus is on current solar cell technology with additional investment in perovskites.

The Ultra High Density Hybrid Energy Storage Module effort (HD HESM) is a follow-on from P456. The team initiated contracting through the Air Force Research Lab for a new High Density System, developed cross service System Requirements (Navy, Army and AF), and initiated platform analysis for HD HESM installation and operation.

OECIF continues to co-sponsor, with SERDP/ESTCP, emerging Waste-to-Energy Technology development.

FY 2018 Plans: TMSC, FY 2013 program, transitions to Project Manager Expeditionary Energy and Sustainment Systems and submits the Standard to the Defense Standardization Program Office.
Two FY 2014 analytical methods and tools programs conclude. STORM-E will finalize EF 21 scenario development and analysis. J-DEPLOI will complete software development into MBPS, provide joint data integration, and complete verification and testing of J-DEPLOI capabilities.
FY 2015 vehicle efforts enter the final year of funding. The Automation/Smart Cruise Control program concludes convoy vehicle testing using smart cruise control. TVEK completes baselining performance data; integration and testing of the anti-idle system (DC/DC, inverter, motor/generator, 6T battery, HVAC, and cabin heating); electromagnetic interference testing on TVEK electrified components; and Functional and Preliminary Design Reviews. The Thermal Barrier Coatings program completes testing multiple iterations of coated pistons and

Exhibit R-2A, **RDT&E Project Justification:** PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*

	FY 2017	FY 2018
will configure the engine test cell for testing a thermocouple instrumented piston. The M&S for Lightweighting program completes M&S for emerging novel materials. The FY 2016 efforts continue. The Small Turboprop Engine Range/Power Enhancement program completes engine testing, and the IPTE completes preliminary engine design while acquiring engine fabrication material. The Reliable, Efficient, Tactical UAS Power System program will have an engine for testing. Hybrid Tiger completes airframe fabrication/energy system integration for first flight; evaluates energy performance; tunes software algorithms; refines benchtop assumptions with real-world flight measurements; updates the simulation to match measurements, and informs the hybrid energy design process. The Aluminum Seawater Power program completes breadboard combustor design review and performs testing; selects product-removal hardware and tests; and selects water replenishment hardware and tests. The HTVE-UE program continues tech development including pool testing and final preparations for 1-year at-sea test, continues studies and analyses related to HTV characterization/environmental considerations and various CONOPS. The JP-8 Based Fuel Cell Power program conducts physical integration of the JP-8 reformer and solid oxide fuel cell and all supporting hardware; and conducts the first two iterations of system level tests to shape system design. The FY 2017 efforts continue. The OSCIPPT team completes first release of the subsystem controls, the interface description document, and the coordination control for FY2017 physical architecture. TEAPPS identifies candidate thermal management system architectures and control schemes using the validated dynamic thermal modeling toolset, tests the thermal performance of a single-diode advanced thermal packaging module with phase change material, and completes fabrication of the first of two prototype thermal management systems for demonstration. PTROL team integrates and test systems for two FY 2018 demonstrations: laser power sent over optical fiber to an Unmanned Underwater Vehicle (UUV), and greater than 500W of power transmitted over 300m to a stationary receiver. The W-Band Power Beaming team completes high power testing of samples of promising ceramic absorber materials developed in the first two years; completes modeling and fabrication of the Sterling engine heat pipe; and models collector antenna, integrated absorber, and heat transfer interface. SSP designs models electromagnetic antennas and manifolding; completes efficiency and sensitivity simulations of discrete rectifier; models rf to dc sensitivity, harvesting beam width, and interaction between rectifier loading and Rectenna. FY 2018 will be 1-year studies that illuminate S&T Gaps for Operational Energy in the near-, mid-, and far-term. These efforts are expected to be complete and shape and influence the next DoD OE Strategy.		
Congressional Adds Subtotals	4.953	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 455 / *Operational Energy Capability Improvement*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

None

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense			**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 456 / *Hybrid Energy Storage Module (HESM)*	

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
456: *Hybrid Energy Storage Module (HESM)*	18.163	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

P456, the Hybrid Energy Storage Module (HESM), co-sponsored by the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) and the Assistant Secretary of Defense for Energy, Installations and Environment (ASD(EIE)), develops advanced energy storage technologies to maximize performance and reliability, and enable future high power weapons and sensor systems on legacy and next generation vehicles, aircraft and ships. The goals of HESM are to (1) demonstrate energy storage systems with high power/energy densities, scalable to all power levels, that reduce total logistics demand, (2) increase platform ability to sustain operations during engagement, and (3) reduce maintenance. Once demonstration is complete, this technology will be sustained by the Services and will be used to extend the operational performance and safety for these applications beyond the hybrid storage module baseline design configuration. This program is closely coordinated with the Advanced Management and Protection of Energy-storage Devices (AMPED) program of the Department of Energy's (DOE) Advanced Research Projects Agency - Energy (ARPA-E).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Hybrid Energy Storage Module (HESM) ***Description:*** Co-sponsored by the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) and the Assistant Secretary of Defense for Energy, Installations and Environment (ASD(EIE)), develops advanced energy storage technologies to maximize performance and reliability, and enable future high power weapons and sensor systems on legacy and next generation vehicles, aircraft and ships. The goals of HESM are to (1) demonstrate energy storage systems with high power/energy densities, scalable to all power levels, that reduce total logistics demand, (2) increase platform ability to sustain operations during engagement, and (3) reduce maintenance. Once demonstration is complete, this technology will be sustained by the Services and will be used to extend the operational performance and safety for these applications beyond the hybrid storage module baseline design configuration. This program is closely coordinated with the Advanced Management and Protection of Energy-storage Devices (AMPED) program of the Department of Energy's (DOE) Advanced Research Projects Agency - Energy (ARPA-E). ***FY 2018 Plans:*** Additional capability funded with FY17 Congressional Add money in P455 will continue. ***FY 2019 Plans:*** Additional capability funded with FY17 Congressional Add money in P455 will continue.	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0604055D8Z / *Operational Energy Capability Improvement*	**Project (Number/Name)** 456 / *Hybrid Energy Storage Module (HESM)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

None

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0303310D8Z / *CWMD Systems: Advanced Technology Development*

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	172.581	19.587	33.382	26.644	-	26.644	25.452	25.340	25.120	24.915	Continuing	Continuing
004: *Advanced Technology Demonstration*	172.581	19.587	33.382	26.644	-	26.644	25.452	25.340	25.120	24.915	Continuing	Continuing

Note

Reduction from FY 2018 to FY2019 the result of reallocation of resources across the portfolio in POM-19.

A. Mission Description and Budget Item Justification

The Countering Weapons of Mass Destruction (CWMD) Systems program provides funding for research, development, integration, and deployment of CWMD capabilities. Funding is allocated to a portfolio of projects and activities in response to Combatant Command needs and research initiatives.

The CWMD Systems program is organized to develop, enhance, mature and transition technologies across the RDT&E continuum, from Advanced Technology Development through Operational Systems Development, as well as limited sustainment in unique cases. A focus area is investment in CWMD-related technologies that require additional development to transition them to mature capabilities, in response to validated, prioritized requirements. This effort fills a seam in which capability gaps are not being addressed adequately or sufficiently to meet warfighter needs. The CWMD Systems program closes gaps identified by specialized military units and leverages prior S&T investments to continue development and fielding of operational systems to those units.

The program’s legacy focus on CWMD situational awareness capabilities remains a significant component of the investment portfolio. The Joint Requirements Oversight Council approved the Information Systems Initial Capabilities Document for CWMD Situational Awareness in 2015, which identifies the need for a family of systems to mitigate capability gaps identified by the Combatant Commands. U.S. Special Operations Command, which assumed CWMD mission responsibilities in January 2017 per the Unified Command Plan, is providing focus and direction for development of CWMD situational awareness capabilities. In June 2017, Deputy Commander USSOCOM requested support for development of a DoD CWMD “User Defined Operational Picture” (UDOP) that can access and share relevant WMD intelligence and operational information with DoD mission partners (Combatant Commands, U.S. Government agencies, and key allies). The CWMD Systems program funds initiatives to close CWMD situational awareness gaps by leveraging mature technologies and modifying existing systems. Existing DoD information systems, networks, and applications are utilized and/or modified using CWMD Systems funding. Development of new applications reuses software to the extent possible. The CWMD Systems program also funds technology-enabled analytical cells at the Defense Threat Reduction Agency and the Defense Intelligence Agency, which support Combatant Commands. These cells curate, synthesize, and contextualize CWMD information for end-users. This hybrid approach facilitates cross-organizational information sharing and collaboration, necessary for addressing the transregional character of WMD proliferation.

The CWMD Systems program utilizes four Research, Development, Test & Evaluation (RDT&E) program elements (BA-3 / PE#0303310D8Z, BA-5 / PE#0305310D8Z, BA-6 / PE#0306310D8Z, and BA-7 / PE#0607310D8Z), as well as an Operations and Maintenance (O&M) "CWMD Sustainment" line (PE#0901388D8Z ORC-2531).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Office of the Secretary Of Defense	**Date:** February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* **/** BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0303310D8Z **/** *CWMD Systems: Advanced Technology Development*

This Program Element (PE) funds research, development, testing, and evaluation of materiel and non-materiel solutions to develop CWMD capabilities. Funds are used for development and integration of hardware or software technologies; contractor personnel for fusion cells at DTRA and DIA; research partnerships with DoD and civilian academic institutions, FFRDCs and UARCs; and interagency table-top exercises conducted on behalf of Combatant Commands.

This appropriation funds travel to support the requirements of this program, and work (including manpower) performed by a government agency or by private individuals or organizations under a contractual or grant arrangement with the government who conduct research, development and test and evaluation efforts.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	44.836	33.382	24.471	-	24.471
Current President's Budget	19.587	33.382	26.644	-	26.644
Total Adjustments	-25.249	0.000	2.173	-	2.173
• Congressional General Reductions	-23.600	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Reallocation from other CWMD Systems programs	-	-	2.173	-	2.173
• FFRDC	-0.022	-	-	-	-
• Economic adjustments	-1.627	-	-	-	-

Change Summary Explanation

FY2018 to FY2019 increase the result of reallocation of resources within the portfolio to better support full RDT&E cycle and technology transition.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0303310D8Z / *CWMD Systems: Advanced Technology Development*	**Project (Number/Name)** 004 / *Advanced Technology Demonstration*

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
004: *Advanced Technology Demonstration*	172.581	19.587	33.382	26.644	-	26.644	25.452	25.340	25.120	24.915	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Countering Weapons of Mass Destruction (CWMD) Systems program provides funding for research, development, integration, and deployment of CWMD capabilities. Funding is allocated to a portfolio of projects and activities in response to Combatant Command needs and research initiatives.

The CWMD Systems program is organized to develop, enhance, mature and transition technologies across the RDT&E continuum, from Advanced Technology Development through Operational Systems Development, as well as limited sustainment in unique cases. A focus area is investment in CWMD-related technologies that require additional development to transition them to mature capabilities, in response to validated, prioritized requirements. This effort fills a seam in which capability gaps are not being addressed adequately or sufficiently to meet warfighter needs. The CWMD Systems program closes gaps identified by specialized military units and leverages prior S&T investments to continue development and fielding of operational systems to those units.

The program’s legacy focus on CWMD situational awareness capabilities remains a significant component of the investment portfolio. The Joint Requirements Oversight Council approved the Information Systems Initial Capabilities Document for CWMD Situational Awareness in 2015, which identifies the need for a family of systems to mitigate capability gaps identified by the Combatant Commands. U.S. Special Operations Command, which assumed CWMD mission responsibilities in January 2017 per the Unified Command Plan, is providing focus and direction for development of CWMD situational awareness capabilities. In June 2017, Deputy Commander USSOCOM requested support for development of a DoD CWMD “User Defined Operational Picture” (UDOP) that can access and share relevant WMD intelligence and operational information with DoD mission partners (Combatant Commands, U.S. Government agencies, and key allies). The CWMD Systems program funds initiatives to close CWMD situational awareness gaps by leveraging mature technologies and modifying existing systems. Existing DoD information systems, networks, and applications are utilized and/or modified using CWMD Systems funding. Development of new applications reuses software to the extent possible. The CWMD Systems program also funds technology-enabled analytical cells at the Defense Threat Reduction Agency and the Defense Intelligence Agency, which support Combatant Commands. These cells curate, synthesize, and contextualize CWMD information for end-users. This hybrid approach facilitates cross-organizational information sharing and collaboration, necessary for addressing the transregional character of WMD proliferation.

The CWMD Systems program utilizes four Research, Development, Test & Evaluation (RDT&E) program elements (BA-3 / PE#0303310D8Z, BA-5 / PE#0305310D8Z, BA-6 / PE#0306310D8Z, and BA-7 / PE#0607310D8Z), as well as an Operations and Maintenance (O&M) "CWMD Sustainment" line (PE#0901388D8Z ORC-2531).

This project funds research, development, testing, and evaluation of materiel and non-materiel solutions to develop CWMD capabilities. Funds are used for development and integration of hardware or software technologies; contractor personnel for fusion cells at DTRA and DIA; research partnerships with DoD and civilian academic institutions, FFRDCs and UARCs; and interagency table-top exercises conducted on behalf of Combatant Commands.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0303310D8Z / *CWMD Systems: Advanced Technology Development*	**Project (Number/Name)** 004 / *Advanced Technology Demonstration*

This appropriation funds travel to support the requirements of this program, and work (including manpower) performed by a government agency or by private individuals or organizations under a contractual or grant arrangement with the government who conduct research, development and test and evaluation efforts.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Advanced Technology Demonstration ***Description:*** Research, develop, test, and evaluate materiel and non-materiel solutions to develop CWMD capabilities. Funds are used for development and integration of hardware or software technologies; contractor personnel for fusion cells at DTRA and DIA; research partnerships with DoD and civilian academic institutions, FFRDCs and UARCs; and interagency table-top exercises conducted on behalf of Combatant Commands. ***FY 2018 Plans:*** • Continue development, integration, and/or modification of technologies, systems, and/or applications to meet capability needs of Combatant Commands and specialized military units • Continue support to USSOCOM for development of DoD CWMD "User Defined Operational Picture," including use of DIA and DTRA analytical cells • Conduct table-top exercises and senior leader seminars in support of U.S. Special Operations Command or other Combatant Commands • Continue CWMD-related research studies and analyses ***FY 2019 Plans:*** • Continue development, integration, and/or modification of technologies, systems, and/or applications to meet capability needs of Combatant Commands and specialized military units, building upon projects initiated in FY2017 and FY2018 • Continue support to USSOCOM for development and fielding of DoD CWMD "User Defined Operational Picture," including use of DIA and DTRA analytical cells • Conduct table-top exercises and senior leader seminars in support of U.S. Special Operations Command or other Combatant Commands • Continue CWMD-related research studies and analyses ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction from FY 2018 to FY2019 the result of reallocation of resources across the portfolio in POM-19.	19.587	33.382	26.644
Accomplishments/Planned Programs Subtotals	19.587	33.382	26.644

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Office of the Secretary Of Defense		**Date:** February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0303310D8Z / *CWMD Systems: Advanced Technology Development*	**Project (Number/Name)** 004 / *Advanced Technology Demonstration*

D. Acquisition Strategy

Develop, reuse, or enhance information technologies to field initial capabilities to end-users. As technologies mature and user needs are refined, systems or applications may transition to acquisition program(s) or be sustained separately. Integration of or interoperability among systems is also an acquisition pathway.

E. Performance Metrics

Success in this area is measured by compliance with various statutes and DoD directives that govern the conduct of the affairs within the Office of the Assistant Secretary of Defense for Nuclear, Chemical and Biological Defense Programs (OASD/NCB). Maintain cost, schedule, and performance reporting, review, and adjudication. Maintain requirements traceability matrix.

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