Department of Defense
Fiscal Year (FY) 2018 Budget Estimates

May 2017

Navy

Justification Book Volume 1 of 5

Research, Development, Test & Evaluation, Navy

Budget Activities 1, 2, and 3

The estimated cost for this report or the Department of Navy (ON) is $12,808.

he estimated total cost or supportin the ON bud et usti ication material is appro imately $1,142,960 or the 2017 iscal year. his includes $76,659 in supplies and $1,066,301 in labor.

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Research, Development, Test and Evaluation, Navy

For expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance, rehabilitation, lease, and operation of facilities and equipment, $18,805,400,000 to remain available for obligation until September 30, 2019.

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Department of Defense
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Appropriation	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Research, Development, Test & Eval, Navy	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447
Total Research, Development, Test & Evaluation	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447
Other RDT&E Budget Activities Not Included in the Research, Development, Test and Evaluation Title							
National Defense Sealift Fund	36,289						
Total Not in Research, Development, Test & Evaluation	36,289						

Department of Defense
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Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Appropriation	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Research, Development, Test & Eval, Navy	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400
Total Research, Development, Test & Evaluation	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400
Other RDT&E Budget Activities Not Included in the Research, Development, Test and Evaluation Title							
National Defense Sealift Fund					18,622		18,622
Total Not in Research, Development, Test & Evaluation					18,622		18,622

Department of Defense
FY 2018 President's Budget Request
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Total Obligational Authority
(Dollars in Thousands)

Summary Recap of Budget Activities	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Basic Research	648,642	542,970	542,970				
Applied Research	951,575	861,151	861,151				
Advanced Technology Development	680,933	736,988	736,988				
Advanced Component Development & Prototypes	4,929,981	4,662,867	4,707,367	41,897	77,397		77,397
System Development & Demonstration	6,236,999	6,025,655	6,112,003				
Management Support	1,286,493	853,736	918,322				
Operational Systems Development	3,598,418	3,592,934	3,697,066	36,426	128,626		128,626
Undistributed		800,517	800,517	-42,576	-42,576		-42,576
Total Research, Development, Test & Evaluation	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447
Summary Recap of FYDP Programs							
Strategic Forces	162,023	196,948	196,948				
General Purpose Forces	1,328,376	1,447,043	1,514,004				
Intelligence and Communications	818,572	713,042	713,042				
Research and Development	14,468,006	13,638,282	13,833,716	41,897	77,397		77,397
Central Supply and Maintenance	27,563	52,526	52,526				
Administration and Associated Activities	569	800,517	800,517	-42,576	-42,576		-42,576
Space							
Classified Programs	1,527,932	1,228,460	1,265,631	36,426	128,626		128,626
Total Research, Development, Test & Evaluation	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447

Department of Defense
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Summary Recap of Budget Activities	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Basic Research	542,970	542,970		542,970	595,901		595,901
Applied Research	861,151	861,151		861,151	886,079		886,079
Advanced Technology Development	736,988	736,988		736,988	686,342		686,342
Advanced Component Development & Prototypes	4,704,764	4,784,764		4,784,764	4,218,714	27,710	4,246,424
System Development & Demonstration	6,025,655	6,112,003		6,112,003	6,362,102		6,362,102
Management Support	853,736	918,322		918,322	945,757		945,757
Operational Systems Development	3,629,360	3,825,692		3,825,692	3,980,140	102,655	4,082,795
Undistributed	757,941	757,941		757,941			
Total Research, Development, Test & Evaluation	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400
Summary Recap of FYDP Programs							
Strategic Forces	196,948	196,948		196,948	201,735		201,735
General Purpose Forces	1,447,043	1,514,004		1,514,004	1,675,797	12,800	1,688,597
Intelligence and Communications	713,042	713,042		713,042	751,779		751,779
Research and Development	13,680,179	13,911,113		13,911,113	13,589,349	27,710	13,617,059
Central Supply and Maintenance	52,526	52,526		52,526	43,035		43,035
Administration and Associated Activities	757,941	757,941		757,941	1,749		1,749
Space					47,244		47,244
Classified Programs	1,264,886	1,394,257		1,394,257	1,364,347	89,855	1,454,202
Total Research, Development, Test & Evaluation	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400

Department of Defense
FY 2018 President's Budget Request
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Total Obligational Authority
(Dollars in Thousands)

	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Summary Recap of Non-RDT&E Title FYDP Programs							
Mobility Forces	36,289						
Total Research, Development, Test & Evaluation	36,289						

Department of Defense
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Summary Recap of Non-RDT&E Title FYDP Programs							
Mobility Forces					18,622		18,622
Total Research, Development, Test & Evaluation					18,622		18,622

Department of the Navy
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Summary Recap of Budget Activities	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Basic Research	648,642	542,970	542,970				
Applied Research	951,575	861,151	861,151				
Advanced Technology Development	680,933	736,988	736,988				
Advanced Component Development & Prototypes	4,929,981	4,662,867	4,707,367	41,897	77,397		77,397
System Development & Demonstration	6,236,999	6,025,655	6,112,003				
Management Support	1,286,493	853,736	918,322				
Operational Systems Development	3,598,418	3,592,934	3,697,066	36,426	128,626		128,626
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Total Research, Development, Test & Evaluation	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447
Summary Recap of FYDP Programs							
Strategic Forces	162,023	196,948	196,948				
General Purpose Forces	1,328,376	1,447,043	1,514,004				
Intelligence and Communications	818,572	713,042	713,042				
Research and Development	14,468,006	13,638,282	13,833,716	41,897	77,397		77,397
Central Supply and Maintenance	27,563	52,526	52,526				
Administration and Associated Activities	569	800,517	800,517	-42,576	-42,576		-42,576
Space							
Classified Programs	1,527,932	1,228,460	1,265,631	36,426	128,626		128,626
Total Research, Development, Test & Evaluation	18,333,041	18,076,818	18,376,384	35,747	163,447		163,447

Department of the Navy
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Summary Recap of Budget Activities	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Basic Research	542,970	542,970		542,970	595,901		595,901
Applied Research	861,151	861,151		861,151	886,079		886,079
Advanced Technology Development	736,988	736,988		736,988	686,342		686,342
Advanced Component Development & Prototypes	4,704,764	4,784,764		4,784,764	4,218,714	27,710	4,246,424
System Development & Demonstration	6,025,655	6,112,003		6,112,003	6,362,102		6,362,102
Management Support	853,736	918,322		918,322	945,757		945,757
Operational Systems Development	3,629,360	3,825,692		3,825,692	3,980,140	102,655	4,082,795
Undistributed	757,941	757,941		757,941			
Total Research, Development, Test & Evaluation	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400
Summary Recap of FYDP Programs							
Strategic Forces	196,948	196,948		196,948	201,735		201,735
General Purpose Forces	1,447,043	1,514,004		1,514,004	1,675,797	12,800	1,688,597
Intelligence and Communications	713,042	713,042		713,042	751,779		751,779
Research and Development	13,680,179	13,911,113		13,911,113	13,589,349	27,710	13,617,059
Central Supply and Maintenance	52,526	52,526		52,526	43,035		43,035
Administration and Associated Activities	757,941	757,941		757,941	1,749		1,749
Space					47,244		47,244
Classified Programs	1,264,886	1,394,257		1,394,257	1,364,347	89,855	1,454,202
Total Research, Development, Test & Evaluation	18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400

Department of the Navy
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
1	0601103N	University Research Initiatives	01	140,998	101,714	101,714					U
2	0601152N	In-House Laboratory Independent Research	01	18,978	18,508	18,508					U
3	0601153N	Defense Research Sciences	01	488,666	422,748	422,748					U
	Basic	Research		648,642	542,970	542,970					
4	0602114N	Power Projection Applied Research	02	88,940	41,371	41,371					U
5	0602123N	Force Protection Applied Research	02	174,447	158,745	158,745					U
6	0602131M	Marine Corps Landing Force Technology	02	50,164	51,590	51,590					U
7	0602235N	Common Picture Applied Research	02	42,973	41,185	41,185					U
8	0602236N	Warfighter Sustainment Applied Research	02	44,092	45,467	45,467					U
9	0602271N	Electromagnetic Systems Applied Research	02	116,362	118,941	118,941					U
10	0602435N	Ocean Warfighting Environment Applied Research	02	69,703	42,618	42,618					U
11	0602651M	Joint Non-Lethal Weapons Applied Research	02	5,956	6,327	6,327					U
12	0602747N	Undersea Warfare Applied Research	02	151,844	126,313	126,313					U
13	0602750N	Future Naval Capabilities Applied Research	02	172,511	165,103	165,103					U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02	34,583	33,916	33,916					U
15	0602792N	Innovative Naval Prototypes (INP) Applied Research	02								U

Department of the Navy
FY 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
1	0601103N	University Research Initiatives	01	101,714	101,714		101,714	118,130		118,130	U
2	0601152N	In-House Laboratory Independent Research	01	18,508	18,508		18,508	19,438		19,438	U
3	0601153N	Defense Research Sciences	01	422,748	422,748		422,748	458,333		458,333	U
	Basic	Research		542,970	542,970		542,970	595,901		595,901	
4	0602114N	Power Projection Applied Research	02	41,371	41,371		41,371	13,553		13,553	U
5	0602123N	Force Protection Applied Research	02	158,745	158,745		158,745	125,557		125,557	U
6	0602131M	Marine Corps Landing Force Technology	02	51,590	51,590		51,590	53,936		53,936	U
7	0602235N	Common Picture Applied Research	02	41,185	41,185		41,185	36,450		36,450	U
8	0602236N	Warfighter Sustainment Applied Research	02	45,467	45,467		45,467	48,649		48,649	U
9	0602271N	Electromagnetic Systems Applied Research	02	118,941	118,941		118,941	79,598		79,598	U
10	0602435N	Ocean Warfighting Environment Applied Research	02	42,618	42,618		42,618	42,411		42,411	U
11	0602651M	Joint Non-Lethal Weapons Applied Research	02	6,327	6,327		6,327	6,425		6,425	U
12	0602747N	Undersea Warfare Applied Research	02	126,313	126,313		126,313	56,094		56,094	U
13	0602750N	Future Naval Capabilities Applied Research	02	165,103	165,103		165,103	156,805		156,805	U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02	33,916	33,916		33,916	32,733		32,733	U
15	0602792N	Innovative Naval Prototypes (INP) Applied Research	02					171,146		171,146	U

Department of the Navy
FY 2018 President's Budget Request
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Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
16	0602861N	Science and Technology Management - ONR Field Acitivities	02								U
17	0602898N	Science and Technology Management - ONR Headquarters	02		29,575	29,575					U
		Applied Research		951,575	861,151	861,151					
18	0603114N	Power Projection Advanced Technology	03	41,957	96,406	96,406					U
19	0603123N	Force Protection Advanced Technology	03	42,333	48,438	48,438					U
20	0603271N	Electromagnetic Systems Advanced Technology	03	32,924	26,421	26,421					U
21	0603640M	USMC Advanced Technology Demonstration (ATD)	03	128,386	140,416	140,416					U
22	0603651M	Joint Non-Lethal Weapons Technology Development	03	12,374	13,117	13,117					U
23	0603673N	Future Naval Capabilities Advanced Technology Development	03	251,173	249,092	249,092					U
24	0603680N	Manufacturing Technology Program	03	54,739	56,712	56,712					U
25	0603729N	Warfighter Protection Advanced Technology	03	34,894	4,789	4,789					U
26	0603747N	Undersea Warfare Advanced Technology	03	13,251	25,880	25,880					U
27	0603758N	Navy Warfighting Experiments and Demonstrations	03	65,553	60,550	60,550					U
28	0603782N	Mine and Expeditionary Warfare Advanced Technology	03	3,349	15,167	15,167					U

Department of the Navy
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Appropriation: 1319N Research, Development, Test & Eval, Navy

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16	0602861N	Science and Technology Management - ONR Field Acitivities	02					62,722		62,722	U
17	0602898N	Science and Technology Management - ONR Headquarters	02	29,575	29,575		29,575				U
	Applied Research			861,151	861,151		861,151	886,079		886,079	
18	0603114N	Power Projection Advanced Technology	03	96,406	96,406		96,406				U
19	0603123N	Force Protection Advanced Technology	03	48,438	48,438		48,438	26,342		26,342	U
20	0603271N	Electromagnetic Systems Advanced Technology	03	26,421	26,421		26,421	9,360		9,360	U
21	0603640M	USMC Advanced Technology Demonstration (ATD)	03	140,416	140,416		140,416	154,407		154,407	U
22	0603651M	Joint Non-Lethal Weapons Technology Development	03	13,117	13,117		13,117	13,448		13,448	U
23	0603673N	Future Naval Capabilities Advanced Technology Development	03	249,092	249,092		249,092	231,772		231,772	U
24	0603680N	Manufacturing Technology Program	03	56,712	56,712		56,712	57,797		57,797	U
25	0603729N	Warfighter Protection Advanced Technology	03	4,789	4,789		4,789	4,878		4,878	U
26	0603747N	Undersea Warfare Advanced Technology	03	25,880	25,880		25,880				U
27	0603758N	Navy Warfighting Experiments and Demonstrations	03	60,550	60,550		60,550	64,889		64,889	U
28	0603782N	Mine and Expeditionary Warfare Advanced Technology	03	15,167	15,167		15,167	15,164		15,164	U

Department of the Navy
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(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
29	0603801N	Innovative Naval Prototypes (INP) Advanced Technology Development	03								U
		Advanced Technology Development		680,933	736,988	736,988					
30	0603207N	Air/Ocean Tactical Applications	04	37,126	48,536	48,536					U
31	0603216N	Aviation Survivability	04	5,343	5,239	5,239					U
32	0603237N	Deployable Joint Command and Control	04	3,051							U
33	0603251N	Aircraft Systems	04	25,763	1,519	1,519					U
34	0603254N	ASW Systems Development	04	5,455	7,041	7,041					U
35	0603261N	Tactical Airborne Reconnaissance	04	8,391	3,274	3,274					U
36	0603382N	Advanced Combat Systems Technology	04	1,572	57,034	57,034					U
37	0603502N	Surface and Shallow Water Mine Countermeasures	04	88,092	165,775	165,775					U
38	0603506N	Surface Ship Torpedo Defense	04	69,803	87,066	87,066					U
39	0603512N	Carrier Systems Development	04	8,213	7,605	7,605					U
40	0603525N	PILOT FISH	04	124,194	132,068	132,068					U
41	0603527N	RETRACT LARCH	04	39,475	14,546	14,546	3,907	35,907		35,907	U
42	0603536N	RETRACT JUNIPER	04	109,786	115,435	115,435					U
43	0603542N	Radiological Control	04	709	702	702					U
44	0603553N	Surface ASW	04	1,056	1,081	1,081					U
45	0603561N	Advanced Submarine System Development	04	85,496	100,565	106,365					U

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29	0603801N	Innovative Naval Prototypes (INP) Advanced Technology Development	03					108,285		108,285	U
		Advanced Technology Development		736,988	736,988		736,988	686,342		686,342	
30	0603207N	Air/Ocean Tactical Applications	04	48,536	48,536		48,536	48,365		48,365	U
31	0603216N	Aviation Survivability	04	5,239	5,239		5,239	5,566		5,566	U
32	0603237N	Deployable Joint Command and Control	04								U
33	0603251N	Aircraft Systems	04	1,519	1,519		1,519	695		695	U
34	0603254N	ASW Systems Development	04	7,041	7,041		7,041	7,661		7,661	U
35	0603261N	Tactical Airborne Reconnaissance	04	3,274	3,274		3,274	3,707		3,707	U
36	0603382N	Advanced Combat Systems Technology	04	57,034	57,034		57,034	61,381		61,381	U
37	0603502N	Surface and Shallow Water Mine Countermeasures	04	165,775	165,775		165,775	154,117		154,117	U
38	0603506N	Surface Ship Torpedo Defense	04	87,066	87,066		87,066	14,974		14,974	U
39	0603512N	Carrier Systems Development	04	7,605	7,605		7,605	9,296		9,296	U
40	0603525N	PILOT FISH	04	132,068	132,068		132,068	132,083		132,083	U
41	0603527N	RETRACT LARCH	04	18,453	50,453		50,453	15,407	22,000	37,407	U
42	0603536N	RETRACT JUNIPER	04	115,435	115,435		115,435	122,413		122,413	U
43	0603542N	Radiological Control	04	702	702		702	745		745	U
44	0603553N	Surface ASW	04	1,081	1,081		1,081	1,136		1,136	U
45	0603561N	Advanced Submarine System Development	04	100,565	106,365		106,365	100,955		100,955	U

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46	0603562N	Submarine Tactical Warfare Systems	04	10,172	8,782	8,782					U
47	0603563N	Ship Concept Advanced Design	04	10,446	14,590	14,590					U
48	0603564N	Ship Preliminary Design & Feasibility Studies	04	3,213	15,805	15,805					U
49	0603570N	Advanced Nuclear Power Systems	04	482,040	453,313	453,313					U
50	0603573N	Advanced Surface Machinery Systems	04	23,443	36,655	36,655					U
51	0603576N	CHALK EAGLE	04	493,472	367,016	367,016					U
52	0603581N	Littoral Combat Ship (LCS)	04	109,426	51,630	51,630					U
53	0603582N	Combat System Integration	04	32,020	23,530	26,530					U
54	0603595N	Ohio Replacement	04	947,783	700,811	700,811					U
55	0603596N	LCS Mission Modules	04	188,872	160,058	160,058					U
56	0603597N	Automated Test and Analysis	04	22,188							U
57	0603599N	Frigate Development	04	18,965	84,900	84,900					U
58	0603609N	Conventional Munitions	04	7,676	8,342	8,342					U
59	0603611M	Marine Corps Assault Vehicles	04	196,991	158,682	158,682					U
60	0603635M	Marine Corps Ground Combat/Support System	04	359	1,303	1,303					U
61	0603654N	Joint Service Explosive Ordnance Development	04	14,957	46,911	46,911		3,500		3,500	U
62	0603658N	Cooperative Engagement	04	72,472							U
63	0603713N	Ocean Engineering Technology Development	04	5,135	4,556	4,556					U

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46	0603562N	Submarine Tactical Warfare Systems	04	8,782	8,782		8,782	13,834		13,834	U
47	0603563N	Ship Concept Advanced Design	04	14,590	14,590		14,590	36,891		36,891	U
48	0603564N	Ship Preliminary Design & Feasibility Studies	04	15,805	15,805		15,805	12,012		12,012	U
49	0603570N	Advanced Nuclear Power Systems	04	453,313	453,313		453,313	329,500		329,500	U
50	0603573N	Advanced Surface Machinery Systems	04	36,655	36,655		36,655	29,953		29,953	U
51	0603576N	CHALK EAGLE	04	367,016	367,016		367,016	191,610		191,610	U
52	0603581N	Littoral Combat Ship (LCS)	04	51,630	51,630		51,630	40,991		40,991	U
53	0603582N	Combat System Integration	04	23,530	26,530		26,530	24,674		24,674	U
54	0603595N	Ohio Replacement	04	700,811	700,811		700,811	776,158		776,158	U
55	0603596N	LCS Mission Modules	04	160,058	160,058		160,058	116,871		116,871	U
56	0603597N	Automated Test and Analysis	04					8,052		8,052	U
57	0603599N	Frigate Development	04	84,900	84,900		84,900	143,450		143,450	U
58	0603609N	Conventional Munitions	04	8,342	8,342		8,342	8,909		8,909	U
59	0603611M	Marine Corps Assault Vehicles	04	158,682	158,682		158,682				U
60	0603635M	Marine Corps Ground Combat/Support System	04	1,303	1,303		1,303	1,428		1,428	U
61	0603654N	Joint Service Explosive Ordnance Development	04	46,911	50,411		50,411	53,367		53,367	U
62	0603658N	Cooperative Engagement	04								U
63	0603713N	Ocean Engineering Technology Development	04	4,556	4,556		4,556	8,212		8,212	U

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64	0603721N	Environmental Protection	04	19,286	20,343	20,343					U
65	0603724N	Navy Energy Program	04	54,911	52,479	27,479					U
66	0603725N	Facilities Improvement	04	3,726	5,458	5,458					U
67	0603734N	CHALK CORAL	04	168,960	245,860	245,860					U
68	0603739N	Navy Logistic Productivity	04	3,728	3,089	3,089					U
69	0603746N	RETRACT MAPLE	04	340,897	323,526	323,526					U
70	0603748N	LINK PLUMERIA	04	192,336	318,497	318,497					U
71	0603751N	RETRACT ELM	04	36,086	52,834	52,834					U
72	0603764N	LINK EVERGREEN	04	45,603	48,116	48,116					U
73	0603787N	Special Processes	04	16,769	13,619	13,619					U
74	0603790N	NATO Research and Development	04	8,320	9,867	9,867					U
75	0603795N	Land Attack Technology	04	887	6,015	6,015					U
76	0603851M	Joint Non-Lethal Weapons Testing	04	27,976	27,904	27,904					U
77	0603860N	Joint Precision Approach and Landing Systems - Dem/Val	04	80,313	104,144	104,144					U
78	0603925N	Directed Energy and Electric Weapon Systems	04	41,355	32,700	32,700					U
79	0604112N	Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 - 80)	04	95,408	70,528	70,528					U
80	0604122N	Remote Minehunting System (RMS)	04	16,940	3,001	3,001					U
81	0604272N	Tactical Air Directional Infrared Countermeasures (TADIRCM)	04	18,963	34,920	34,920	37,990	37,990		37,990	U

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64	0603721N	Environmental Protection	04	20,343	20,343		20,343	20,214		20,214	U
65	0603724N	Navy Energy Program	04	52,479	27,479		27,479	50,623		50,623	U
66	0603725N	Facilities Improvement	04	5,458	5,458		5,458	2,837		2,837	U
67	0603734N	CHALK CORAL	04	245,860	245,860		245,860	245,143		245,143	U
68	0603739N	Navy Logistic Productivity	04	3,089	3,089		3,089	2,995		2,995	U
69	0603746N	RETRACT MAPLE	04	323,526	323,526		323,526	306,101		306,101	U
70	0603748N	LINK PLUMERIA	04	318,497	318,497		318,497	253,675		253,675	U
71	0603751N	RETRACT ELM	04	52,834	52,834		52,834	55,691		55,691	U
72	0603764N	LINK EVERGREEN	04	48,116	48,116		48,116	48,982		48,982	U
73	0603787N	Special Processes	04	13,619	13,619		13,619				U
74	0603790N	NATO Research and Development	04	9,867	9,867		9,867	9,099		9,099	U
75	0603795N	Land Attack Technology	04	6,015	6,015		6,015	33,568		33,568	U
76	0603851M	Joint Non-Lethal Weapons Testing	04	27,904	27,904		27,904	29,873		29,873	U
77	0603860N	Joint Precision Approach and Landing Systems - Dem/Val	04	104,144	104,144		104,144	106,391		106,391	U
78	0603925N	Directed Energy and Electric Weapon Systems	04	32,700	32,700		32,700	107,310		107,310	U
79	0604112N	Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 - 80)	04	70,528	70,528		70,528	83,935		83,935	U
80	0604122N	Remote Minehunting System (RMS)	04	3,001	3,001		3,001				U
81	0604272N	Tactical Air Directional Infrared Countermeasures (TADIRCM)	04	72,910	72,910		72,910	46,844	5,710	52,554	U

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82	0604279N	ASE Self-Protection Optimization	04	8,995							U
83	0604286M	Marine Corps Additive Manufacturing Technology Development	04								U
84	0604292N	MH-XX	04	4,462	1,620	1,620					U
85	0604320M	Rapid Technology Capability Prototype	04								U
86	0604454N	LX (R)	04	73,392	6,354	6,354					U
87	0604536N	Advanced Undersea Prototyping	04		78,589	78,589					U
88	0604653N	Joint Counter Radio Controlled IED Electronic Warfare (JCREW)	04	3,765							U
89	0604659N	Precision Strike Weapons Development Program	04	7,621	9,910	9,910					U
90	0604707N	Space and Electronic Warfare (SEW) Architecture/Engineering Support	04	22,214	23,971	23,971					U
91	0604786N	Offensive Anti-Surface Warfare Weapon Development	04	348,708	252,409	313,109					U
92	0605812M	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	04	24,790	23,197	23,197					U
93	0303354N	ASW Systems Development - MIP	04	9,835	9,110	9,110					U
94	0304240M	Advanced Tactical Unmanned Aircraft System	04								U
95	0304270N	Electronic Warfare Development - MIP	04	580	437	437					U
		Advanced Component Development & Prototypes		4,929,981	4,662,867	4,707,367	41,897	77,397		77,397	
96	0603208N	Training System Aircraft	05	16,438	19,938	19,938					U

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82	0604279N	ASE Self-Protection Optimization	04								U
83	0604286M	Marine Corps Additive Manufacturing Technology Development	04					6,200		6,200	U
84	0604292N	MH-XX	04	1,620	1,620		1,620				U
85	0604320M	Rapid Technology Capability Prototype	04					7,055		7,055	U
86	0604454N	LX (R)	04	6,354	6,354		6,354	9,578		9,578	U
87	0604536N	Advanced Undersea Prototyping	04	78,589	78,589		78,589	66,543		66,543	U
88	0604653N	Joint Counter Radio Controlled IED Electronic Warfare (JCREW)	04								U
89	0604659N	Precision Strike Weapons Development Program	04	9,910	9,910		9,910	31,315		31,315	U
90	0604707N	Space and Electronic Warfare (SEW) Architecture/Engineering Support	04	23,971	23,971		23,971	42,851		42,851	U
91	0604786N	Offensive Anti-Surface Warfare Weapon Development	04	252,409	313,109		313,109	160,694		160,694	U
92	0605812M	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	04	23,197	23,197		23,197				U
93	0303354N	ASW Systems Development - MIP	04	9,110	9,110		9,110	8,278		8,278	U
94	0304240M	Advanced Tactical Unmanned Aircraft System	04					7,979		7,979	U
95	0304270N	Electronic Warfare Development - MIP	04	437	437		437	527		527	U
		Advanced Component Development & Prototypes		4,704,764	4,784,764		4,784,764	4,218,714	27,710	4,246,424	
96	0603208N	Training System Aircraft	05	19,938	19,938		19,938	16,945		16,945	U

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97	0604212N	Other Helo Development	05	12,070	6,268	6,268					U
98	0604214N	AV-8B Aircraft - Eng Dev	05	26,939	33,664	34,902					U
99	0604215N	Standards Development	05	48,677	1,300	1,300					U
100	0604216N	Multi-Mission Helicopter Upgrade Development	05	17,518	5,275	5,275					U
101	0604218N	Air/Ocean Equipment Engineering	05	4,406	3,875	3,875					U
102	0604221N	P-3 Modernization Program	05	1,485	1,909	1,909					U
103	0604230N	Warfare Support System	05	5,740	13,237	13,237					U
104	0604231N	Tactical Command System	05	75,508	36,323	40,323					U
105	0604234N	Advanced Hawkeye	05	211,146	363,792	363,792					U
106	0604245N	H-1 Upgrades	05	26,768	27,441	27,441					U
107	0604261N	Acoustic Search Sensors	05	30,637	34,525	34,525					U
108	0604262N	V-22A	05	74,366	174,423	189,423					U
109	0604264N	Air Crew Systems Development	05	10,201	13,577	13,577					U
110	0604269N	EA-18	05	45,384	116,761	116,761					U
111	0604270N	Electronic Warfare Development	05	22,383	48,766	92,766					U
112	0604273N	Executive Helo Development	05	490,768	338,357	338,357					U
113	0604274N	Next Generation Jammer (NGJ)	05	376,548	577,822	577,822					U
114	0604280N	Joint Tactical Radio System - Navy (JTRS-Navy)	05	24,300	2,365	2,365					U
115	0604282N	Next Generation Jammer (NGJ) Increment II	05	12,306	52,065	52,065					U

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97	0604212N	Other Helo Development	05	6,268	6,268		6,268	26,786		26,786	U
98	0604214N	AV-8B Aircraft - Eng Dev	05	33,664	34,902		34,902	48,780		48,780	U
99	0604215N	Standards Development	05	1,300	1,300		1,300	2,722		2,722	U
100	0604216N	Multi-Mission Helicopter Upgrade Development	05	5,275	5,275		5,275	5,371		5,371	U
101	0604218N	Air/Ocean Equipment Engineering	05	3,875	3,875		3,875	782		782	U
102	0604221N	P-3 Modernization Program	05	1,909	1,909		1,909	1,361		1,361	U
103	0604230N	Warfare Support System	05	13,237	13,237		13,237	14,167		14,167	U
104	0604231N	Tactical Command System	05	36,323	40,323		40,323	55,695		55,695	U
105	0604234N	Advanced Hawkeye	05	363,792	363,792		363,792	292,535		292,535	U
106	0604245N	H-1 Upgrades	05	27,441	27,441		27,441	61,288		61,288	U
107	0604261N	Acoustic Search Sensors	05	34,525	34,525		34,525	37,167		37,167	U
108	0604262N	V-22A	05	174,423	189,423		189,423	171,386		171,386	U
109	0604264N	Air Crew Systems Development	05	13,577	13,577		13,577	13,235		13,235	U
110	0604269N	EA-18	05	116,761	116,761		116,761	173,488		173,488	U
111	0604270N	Electronic Warfare Development	05	48,766	92,766		92,766	54,055		54,055	U
112	0604273N	Executive Helo Development	05	338,357	338,357		338,357	451,938		451,938	U
113	0604274N	Next Generation Jammer (NGJ)	05	577,822	577,822		577,822	632,936		632,936	U
114	0604280N	Joint Tactical Radio System - Navy (JTRS-Navy)	05	2,365	2,365		2,365	4,310		4,310	U
115	0604282N	Next Generation Jammer (NGJ) Increment II	05	52,065	52,065		52,065	66,686		66,686	U

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116	0604307N	Surface Combatant Combat System Engineering	05	430,450	282,764	282,764					U
117	0604311N	LPD-17 Class Systems Integration	05	730	580	580					U
118	0604329N	Small Diameter Bomb (SDB)	05	55,818	97,622	97,622					U
119	0604366N	Standard Missile Improvements	05	111,295	120,561	120,561					U
120	0604373N	Airborne MCM	05	9,399	45,622	45,622					U
121	0604376M	Marine Air Ground Task Force (MAGTF) Electronic Warfare (EW) for Aviation	05	3,281							U
122	0604378N	Naval Integrated Fire Control - Counter Air Systems Engineering	05	22,960	25,750	25,750					U
123	0604404N	Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) System	05	414,376							U
124	0604501N	Advanced Above Water Sensors	05	42,796	85,868	85,868					U
125	0604503N	SSN-688 and Trident Modernization	05	106,342	117,476	117,476					U
126	0604504N	Air Control	05	55,947	47,404	47,404					U
127	0604512N	Shipboard Aviation Systems	05	117,401	112,158	112,158					U
128	0604518N	Combat Information Center Conversion	05		6,283	6,283					U
129	0604522N	Air and Missile Defense Radar (AMDR) System	05	227,051	144,395	144,395					U
130	0604558N	New Design SSN	05	150,442	113,013	113,013					U
131	0604562N	Submarine Tactical Warfare System	05	51,054	43,160	43,160					U
132	0604567N	Ship Contract Design/ Live Fire T&E	05	38,060	65,002	63,311					U

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116	0604307N	Surface Combatant Combat System Engineering	05	282,764	282,764		282,764	390,238		390,238	U
117	0604311N	LPD-17 Class Systems Integration	05	580	580		580	689		689	U
118	0604329N	Small Diameter Bomb (SDB)	05	97,622	97,622		97,622	112,846		112,846	U
119	0604366N	Standard Missile Improvements	05	120,561	120,561		120,561	158,578		158,578	U
120	0604373N	Airborne MCM	05	45,622	45,622		45,622	15,734		15,734	U
121	0604376M	Marine Air Ground Task Force (MAGTF) Electronic Warfare (EW) for Aviation	05								U
122	0604378N	Naval Integrated Fire Control - Counter Air Systems Engineering	05	25,750	25,750		25,750	25,445		25,445	U
123	0604404N	Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) System	05								U
124	0604501N	Advanced Above Water Sensors	05	85,868	85,868		85,868	87,233		87,233	U
125	0604503N	SSN-688 and Trident Modernization	05	117,476	117,476		117,476	130,981		130,981	U
126	0604504N	Air Control	05	47,404	47,404		47,404	75,186		75,186	U
127	0604512N	Shipboard Aviation Systems	05	112,158	112,158		112,158	177,926		177,926	U
128	0604518N	Combat Information Center Conversion	05	6,283	6,283		6,283	8,062		8,062	U
129	0604522N	Air and Missile Defense Radar (AMDR) System	05	144,395	144,395		144,395	32,090		32,090	U
130	0604558N	New Design SSN	05	113,013	113,013		113,013	120,087		120,087	U
131	0604562N	Submarine Tactical Warfare System	05	43,160	43,160		43,160	50,850		50,850	U
132	0604567N	Ship Contract Design/ Live Fire T&E	05	65,002	63,311		63,311	67,166		67,166	U

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133	0604574N	Navy Tactical Computer Resources	05	4,053	3,098	3,098					U
134	0604580N	Virginia Payload Module (VPM)	05	162,168	97,920	97,920					U
135	0604601N	Mine Development	05	12,602	10,490	15,290					U
136	0604610N	Lightweight Torpedo Development	05	42,548	20,178	20,178					U
137	0604654N	Joint Service Explosive Ordnance Development	05	8,123	7,369	7,369					U
138	0604703N	Personnel, Training, Simulation, and Human Factors	05	7,408	4,995	18,995					U
139	0604727N	Joint Standoff Weapon Systems	05	394	412	412					U
140	0604755N	Ship Self Defense (Detect & Control)	05	145,229	134,619	134,619					U
141	0604756N	Ship Self Defense (Engage: Hard Kill)	05	93,481	114,475	114,475					U
142	0604757N	Ship Self Defense (Engage: Soft Kill/EW)	05	100,153	114,211	114,211					U
143	0604761N	Intelligence Engineering	05	2,053	11,029	13,029					U
144	0604771N	Medical Development	05	24,658	9,220	9,221					U
145	0604777N	Navigation/ID System	05	32,339	42,723	42,723					U
146	0604800M	Joint Strike Fighter (JSF) - EMD	05	526,247	531,426	531,426					U
147	0604800N	Joint Strike Fighter (JSF) - EMD	05	488,703	528,716	528,716					U
148	0604810M	Joint Strike Fighter Follow On Modernization (FoM) - Marine Corps	05	20,157	74,227	74,227					U
149	0604810N	Joint Strike Fighter Follow On Modernization (FoM) - Navy	05	20,544	63,387	63,387					U

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133	0604574N	Navy Tactical Computer Resources	05	3,098	3,098		3,098	4,817		4,817	U
134	0604580N	Virginia Payload Module (VPM)	05	97,920	97,920		97,920	72,861		72,861	U
135	0604601N	Mine Development	05	10,490	15,290		15,290	25,635		25,635	U
136	0604610N	Lightweight Torpedo Development	05	20,178	20,178		20,178	28,076		28,076	U
137	0604654N	Joint Service Explosive Ordnance Development	05	7,369	7,369		7,369	7,561		7,561	U
138	0604703N	Personnel, Training, Simulation, and Human Factors	05	4,995	18,995		18,995	40,828		40,828	U
139	0604727N	Joint Standoff Weapon Systems	05	412	412		412	435		435	U
140	0604755N	Ship Self Defense (Detect & Control)	05	134,619	134,619		134,619	161,713		161,713	U
141	0604756N	Ship Self Defense (Engage: Hard Kill)	05	114,475	114,475		114,475	212,412		212,412	U
142	0604757N	Ship Self Defense (Engage: Soft Kill/EW)	05	114,211	114,211		114,211	103,391		103,391	U
143	0604761N	Intelligence Engineering	05	11,029	13,029		13,029	34,855		34,855	U
144	0604771N	Medical Development	05	9,220	9,221		9,221	9,353		9,353	U
145	0604777N	Navigation/ID System	05	42,723	42,723		42,723	92,546		92,546	U
146	0604800M	Joint Strike Fighter (JSF) - EMD	05	531,426	531,426		531,426	152,934		152,934	U
147	0604800N	Joint Strike Fighter (JSF) - EMD	05	528,716	528,716		528,716	108,931		108,931	U
148	0604810M	Joint Strike Fighter Follow On Modernization (FoM) - Marine Corps	05	74,227	74,227		74,227	144,958		144,958	U
149	0604810N	Joint Strike Fighter Follow On Modernization (FoM) - Navy	05	63,387	63,387		63,387	143,855		143,855	U

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150	0605013M	Information Technology Development	05	3,915	4,856	4,856					U
151	0605013N	Information Technology Development	05	77,895	97,066	97,066					U
152	0605024N	Anti-Tamper Technology Support	05		2,500	2,500					U
153	0605212N	CH-53K RDTE	05	563,174	404,810	404,810					U
154	0605215N	Mission Planning	05		33,570	33,570					U
155	0605217N	Common Avionics	05		51,599	54,599					U
156	0605220N	Ship to Shore Connector (SSC)	05	7,734	11,088	11,088					U
157	0605327N	T-AO 205 Class	05		1,095	1,095					U
158	0605414N	Unmanned Carrier Aviation (UCA)	05		89,000	89,000					U
159	0605450N	Joint Air-to-Ground Missile (JAGM)	05	25,640	17,880	17,880					U
160	0605500N	Multi-mission Maritime Aircraft (MMA)	05	151,472	59,126	59,126					U
161	0605504N	Multi-Mission Maritime (MMA) Increment III	05	89,686	182,220	182,220					U
162	0605611M	Marine Corps Assault Vehicles System Development & Demonstration	05								U
163	0605813M	Joint Light Tactical Vehicle (JLTV) System Development & Demonstration	05								U
164	0204202N	DDG-1000	05	101,724	45,642	45,642					U
165	0303167N	Pre-Auction Spectrum Relocation***	05	131							U
166	0303267N	Auctioned Spectrum Relocation Fund***	05	108,490							U
167	0304231N	Tactical Command System - MIP	05	998	676	676					U

***Funding in this line item was transferred during the year of execution from the Spectrum Relocation Fund (SRF) in support of the Advanced Wireless Services 3 (AWS-3) auction and is associated with the reallocation or sharing of the 1755-1780 MHz and 1695-1710 MHz bands. The SRF is administered by the Office of Management and Budget (OMB), which approves SRF transfers to federal agencies on an annual basis in consultation with the National Telecommunications and Information Administration (NTIA).

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150	0605013M	Information Technology Development	05	4,856	4,856		4,856	14,865		14,865	U
151	0605013N	Information Technology Development	05	97,066	97,066		97,066	152,977		152,977	U
152	0605024N	Anti-Tamper Technology Support	05	2,500	2,500		2,500	3,410		3,410	U
153	0605212N	CH-53K RDTE	05	404,810	404,810		404,810	340,758		340,758	U
154	0605215N	Mission Planning	05	33,570	33,570		33,570	33,430		33,430	U
155	0605217N	Common Avionics	05	51,599	54,599		54,599	58,163		58,163	U
156	0605220N	Ship to Shore Connector (SSC)	05	11,088	11,088		11,088	22,410		22,410	U
157	0605327N	T-AO 205 Class	05	1,095	1,095		1,095	1,961		1,961	U
158	0605414N	Unmanned Carrier Aviation (UCA)	05	89,000	89,000		89,000	222,208		222,208	U
159	0605450N	Joint Air-to-Ground Missile (JAGM)	05	17,880	17,880		17,880	15,473		15,473	U
160	0605500N	Multi-mission Maritime Aircraft (MMA)	05	59,126	59,126		59,126	11,795		11,795	U
161	0605504N	Multi-Mission Maritime (MMA) Increment III	05	182,220	182,220		182,220	181,731		181,731	U
162	0605611M	Marine Corps Assault Vehicles System Development & Demonstration	05					178,993		178,993	U
163	0605813M	Joint Light Tactical Vehicle (JLTV) System Development & Demonstration	05					20,710		20,710	U
164	0204202N	DDG-1000	05	45,642	45,642		45,642	140,500		140,500	U
165	0303167N	Pre-Auction Spectrum Relocation***	05								U
166	0303267N	Auctioned Spectrum Relocation Fund***	05								U
167	0304231N	Tactical Command System - MIP	05	676	676		676				U

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168	0304785N	Tactical Cryptologic Systems	05	17,785	36,747	36,747					U
169	0305124N	Special Applications Program	05	26,505	35,002	35,002					U
170	0306250M	Cyber Operations Technology Development	05		4,942	4,942					U
		System Development & Demonstration		6,236,999	6,025,655	6,112,003					
171	0604256N	Threat Simulator Development	06	30,323	16,633	16,633					U
172	0604258N	Target Systems Development	06	58,730	36,662	36,662					U
173	0604759N	Major T&E Investment	06	66,538	42,109	42,109					U
174	0605126N	Joint Theater Air and Missile Defense Organization	06	6,799	2,998	2,998					U
175	0605152N	Studies and Analysis Support - Navy	06	4,141	3,931	3,931					U
176	0605154N	Center for Naval Analyses	06	45,558	46,634	46,634					U
177	0605285N	Next Generation Fighter	06	5,909	1,200	1,200					U
178	0605502N	Small Business Innovative Research	06	384,569							U
179	0605804N	Technical Information Services	06	1,328	903	903					U
180	0605853N	Management, Technical & International Support	06	77,073	87,077	87,077					U
181	0605856N	Strategic Technical Support	06	3,140	3,597	3,597					U
182	0605861N	RDT&E Science and Technology Management	06	76,872	62,811	63,000					U
183	0605863N	RDT&E Ship and Aircraft Support	06	128,715	106,093	106,093					U
184	0605864N	Test and Evaluation Support	06	351,469	349,146	413,446					U

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168	0304785N	Tactical Cryptologic Systems	05	36,747	36,747		36,747	28,311		28,311	U
169	0305124N	Special Applications Program	05	35,002	35,002		35,002				U
170	0306250M	Cyber Operations Technology Development	05	4,942	4,942		4,942	4,502		4,502	U
		System Development & Demonstration		6,025,655	6,112,003		6,112,003	6,362,102		6,362,102	
171	0604256N	Threat Simulator Development	06	16,633	16,633		16,633	91,819		91,819	U
172	0604258N	Target Systems Development	06	36,662	36,662		36,662	23,053		23,053	U
173	0604759N	Major T&E Investment	06	42,109	42,109		42,109	52,634		52,634	U
174	0605126N	Joint Theater Air and Missile Defense Organization	06	2,998	2,998		2,998	141		141	U
175	0605152N	Studies and Analysis Support - Navy	06	3,931	3,931		3,931	3,917		3,917	U
176	0605154N	Center for Naval Analyses	06	46,634	46,634		46,634	50,432		50,432	U
177	0605285N	Next Generation Fighter	06	1,200	1,200		1,200				U
178	0605502N	Small Business Innovative Research	06								U
179	0605804N	Technical Information Services	06	903	903		903	782		782	U
180	0605853N	Management, Technical & International Support	06	87,077	87,077		87,077	94,562		94,562	U
181	0605856N	Strategic Technical Support	06	3,597	3,597		3,597	4,313		4,313	U
182	0605861N	RDT&E Science and Technology Management	06	62,811	63,000		63,000	1,104		1,104	U
183	0605863N	RDT&E Ship and Aircraft Support	06	106,093	106,093		106,093	105,666		105,666	U
184	0605864N	Test and Evaluation Support	06	349,146	413,446		413,446	373,667		373,667	U

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185	0605865N	Operational Test and Evaluation Capability	06	17,796	18,160	18,199					U
186	0605866N	Navy Space and Electronic Warfare (SEW) Support	06	6,316	9,658	9,658					U
187	0605867N	SEW Surveillance/Reconnaissance Support	06	6,519	6,500	6,500					U
188	0605873M	Marine Corps Program Wide Support	06	14,129	22,247	22,247					U
189	0605898N	Management HQ - R&D	06		16,254	16,312					U
190	0606355N	Warfare Innovation Management	06		21,123	21,123					U
191	0902498N	Management Headquarters (Departmental Support Activities)	06								U
192	0909980N	Judgment Fund Reimbursement	06	398							U
193	0909999N	Financing for Cancelled Account Adjustments	06	171							U
194	1206867N	SEW Surveillance/Reconnaissance Support	06								U
		Management Support		1,286,493	853,736	918,322					
196	0607658N	Cooperative Engagement Capability (CEC)	07		84,501	84,501					U
197	0607700N	Deployable Joint Command and Control	07		2,970	2,970					U
198	0101221N	Strategic Sub & Weapons System Support	07	96,078	136,556	136,556					U
199	0101224N	SSBN Security Technology Program	07	45,166	33,845	33,845					U
200	0101226N	Submarine Acoustic Warfare Development	07	4,658	9,329	9,329					U

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185	0605865N	Operational Test and Evaluation Capability	06	18,160	18,199		18,199	20,298		20,298	U
186	0605866N	Navy Space and Electronic Warfare (SEW) Support	06	9,658	9,658		9,658	17,341		17,341	U
187	0605867N	SEW Surveillance/Reconnaissance Support	06	6,500	6,500		6,500				U
188	0605873M	Marine Corps Program Wide Support	06	22,247	22,247		22,247	21,751		21,751	U
189	0605898N	Management HQ - R&D	06	16,254	16,312		16,312	44,279		44,279	U
190	0606355N	Warfare Innovation Management	06	21,123	21,123		21,123	28,841		28,841	U
191	0902498N	Management Headquarters (Departmental Support Activities)	06					1,749		1,749	U
192	0909980N	Judgment Fund Reimbursement	06								U
193	0909999N	Financing for Cancelled Account Adjustments	06								U
194	1206867N	SEW Surveillance/Reconnaissance Support	06					9,408		9,408	U
		Management Support		853,736	918,322		918,322	945,757		945,757	
196	0607658N	Cooperative Engagement Capability (CEC)	07	84,501	84,501		84,501	92,571		92,571	U
197	0607700N	Deployable Joint Command and Control	07	2,970	2,970		2,970	3,137		3,137	U
198	0101221N	Strategic Sub & Weapons System Support	07	136,556	136,556		136,556	135,219		135,219	U
199	0101224N	SSBN Security Technology Program	07	33,845	33,845		33,845	36,242		36,242	U
200	0101226N	Submarine Acoustic Warfare Development	07	9,329	9,329		9,329	12,053		12,053	U

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201	0101402N	Navy Strategic Communications	07	16,121	17,218	17,218					U
202	0203761N	Rapid Technology Transition (RTT)	07	7,626							U
203	0204136N	F/A-18 Squadrons	07	132,905	189,125	189,125					U
204	0204163N	Fleet Telecommunications (Tactical)	07	39,548	48,225	48,225					U
205	0204228N	Surface Support	07	28,210	21,156	21,156					U
206	0204229N	Tomahawk and Tomahawk Mission Planning Center (TMPC)	07	26,650	71,355	91,355					U
207	0204311N	Integrated Surveillance System	07	76,204	58,542	58,542					U
208	0204413N	Amphibious Tactical Support Units (Displacement Craft)	07	11,330	13,929	13,929					U
209	0204460M	Ground/Air Task Oriented Radar (G/ ATOR)	07	61,348	83,538	83,538					U
210	0204571N	Consolidated Training Systems Development	07	32,902	38,593	38,593					U
211	0204574N	Cryptologic Direct Support	07	1,915	1,122	1,122					U
212	0204575N	Electronic Warfare (EW) Readiness Support	07	44,727	99,998	99,998					U
213	0205601N	HARM Improvement	07	28,063	48,635	48,635					U
214	0205604N	Tactical Data Links	07	138,549	124,785	124,785					U
215	0205620N	Surface ASW Combat System Integration	07	23,685	24,583	24,583					U
216	0205632N	MK-48 ADCAP	07	47,496	39,134	39,134					U
217	0205633N	Aviation Improvements	07	103,685	120,861	120,861					U

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201	0101402N	Navy Strategic Communications	07	17,218	17,218		17,218	18,221		18,221	U
202	0203761N	Rapid Technology Transition (RTT)	07								U
203	0204136N	F/A-18 Squadrons	07	189,125	189,125		189,125	224,470		224,470	U
204	0204163N	Fleet Telecommunications (Tactical)	07	48,225	48,225		48,225	33,525		33,525	U
205	0204228N	Surface Support	07	21,156	21,156		21,156	24,829		24,829	U
206	0204229N	Tomahawk and Tomahawk Mission Planning Center (TMPC)	07	71,355	91,355		91,355	133,617		133,617	U
207	0204311N	Integrated Surveillance System	07	58,542	58,542		58,542	38,972	11,600	50,572	U
208	0204413N	Amphibious Tactical Support Units (Displacement Craft)	07	13,929	13,929		13,929	3,940		3,940	U
209	0204460M	Ground/Air Task Oriented Radar (G/ATOR)	07	83,538	83,538		83,538	54,645		54,645	U
210	0204571N	Consolidated Training Systems Development	07	38,593	38,593		38,593	66,518		66,518	U
211	0204574N	Cryptologic Direct Support	07	1,122	1,122		1,122	1,155	1,200	2,355	U
212	0204575N	Electronic Warfare (EW) Readiness Support	07	99,998	99,998		99,998	51,040		51,040	U
213	0205601N	HARM Improvement	07	48,635	48,635		48,635	87,989		87,989	U
214	0205604N	Tactical Data Links	07	124,785	124,785		124,785	89,852		89,852	U
215	0205620N	Surface ASW Combat System Integration	07	24,583	24,583		24,583	29,351		29,351	U
216	0205632N	MK-48 ADCAP	07	39,134	39,134		39,134	68,553		68,553	U
217	0205633N	Aviation Improvements	07	120,861	120,861		120,861	119,099		119,099	U

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Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
218	0205675N	Operational Nuclear Power Systems	07	101,323	101,786	101,786					U
219	0206313M	Marine Corps Communications Systems	07	84,017	82,159	118,146					U
220	0206335M	Common Aviation Command and Control System (CAC2S)	07	13,959	11,850	11,850					U
221	0206623M	Marine Corps Ground Combat/ Supporting Arms Systems	07	55,058	47,877	51,835					U
222	0206624M	Marine Corps Combat Services Support	07	23,423	13,194	13,194					U
223	0206625M	USMC Intelligence/Electronic Warfare Systems (MIP)	07	13,373	17,171	24,187					U
224	0206629M	Amphibious Assault Vehicle	07	41,363	38,020	38,020					U
225	0207161N	Tactical AIM Missiles	07	59,053	56,285	56,285					U
226	0207163N	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07	30,240	40,350	40,350					U
227	0219902M	Global Combat Support System - Marine Corps (GCSS-MC)	07		9,128	9,128					U
231	0303109N	Satellite Communications (SPACE)	07	45,946	37,372	37,372					U
232	0303138N	Consolidated Afloat Network Enterprise Services (CANES)	07	21,522	23,541	23,541					U
233	0303140N	Information Systems Security Program	07	29,491	38,510	38,510					U
235	0305160N	Navy Meteorological and Ocean Sensors-Space (METOC)	07	599							U
236	0305192N	Military Intelligence Program (MIP) Activities	07	6,207	6,019	6,019					U
237	0305204N	Tactical Unmanned Aerial Vehicles	07	8,550	8,436	8,436					U

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Total Obligational Authority
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Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
218	0205675N	Operational Nuclear Power Systems	07	101,786	101,786		101,786	127,445		127,445	U
219	0206313M	Marine Corps Communications Systems	07	82,159	118,146		118,146	123,825		123,825	U
220	0206335M	Common Aviation Command and Control System (CAC2S)	07	11,850	11,850		11,850	7,343		7,343	U
221	0206623M	Marine Corps Ground Combat/ Supporting Arms Systems	07	47,877	51,835		51,835	66,009		66,009	U
222	0206624M	Marine Corps Combat Services Support	07	13,194	13,194		13,194	25,258		25,258	U
223	0206625M	USMC Intelligence/Electronic Warfare Systems (MIP)	07	17,171	24,187		24,187	30,886		30,886	U
224	0206629M	Amphibious Assault Vehicle	07	38,020	38,020		38,020	58,728		58,728	U
225	0207161N	Tactical AIM Missiles	07	56,285	56,285		56,285	42,884		42,884	U
226	0207163N	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07	40,350	40,350		40,350	25,364		25,364	U
227	0219902M	Global Combat Support System - Marine Corps (GCSS-MC)	07	9,128	9,128		9,128				U
231	0303109N	Satellite Communications (SPACE)	07	37,372	37,372		37,372				U
232	0303138N	Consolidated Afloat Network Enterprise Services (CANES)	07	23,541	23,541		23,541	24,271		24,271	U
233	0303140N	Information Systems Security Program	07	38,510	38,510		38,510	50,269		50,269	U
235	0305160N	Navy Meteorological and Ocean Sensors-Space (METOC)	07								U
236	0305192N	Military Intelligence Program (MIP) Activities	07	6,019	6,019		6,019	6,352		6,352	U
237	0305204N	Tactical Unmanned Aerial Vehicles	07	8,436	8,436		8,436	7,770		7,770	U

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Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
238	0305205N	UAS Integration and Interoperability	07	42,202	36,509	36,509					U
239	0305208M	Distributed Common Ground/Surface Systems	07	1,105	2,100	2,100					U
240	0305208N	Distributed Common Ground/Surface Systems	07	23,149	44,571	44,571					U
241	0305220N	MQ-4C Triton	07	237,118	111,729	111,729					U
242	0305231N	MQ-8 UAV	07	52,770	26,518	26,518					U
243	0305232M	RQ-11 UAV	07	635	418	418					U
244	0305233N	RQ-7 UAV	07	688	716	716					U
245	0305234N	Small (Level 0) Tactical UAS (STUASL0)	07	4,647	5,071	5,071					U
246	0305239M	RQ-21A	07	6,251	9,497	9,497					U
247	0305241N	Multi-Intelligence Sensor Development	07	39,645	77,965	77,965					U
248	0305242M	Unmanned Aerial Systems (UAS) Payloads (MIP)	07	9,246	11,181	11,181					U
249	0305421N	RQ-4 Modernization	07	119,892	181,266	181,266					U
250	0308601N	Modeling and Simulation Support	07	4,585	4,709	4,709					U
251	0702207N	Depot Maintenance (Non-IF)	07	23,401	49,322	49,322					U
252	0708730N	Maritime Technology (MARITECH)	07	4,162	3,204	3,204					U
253	1203109N	Satellite Communications (SPACE)	07								U
9999	9999999999	Classified Programs		1,527,932	1,228,460	1,265,631	36,426	128,626		128,626	U
		Operational Systems Development		3,598,418	3,592,934	3,697,066					

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Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
238	0305205N	UAS Integration and Interoperability	07	36,509	36,509		36,509	39,736		39,736	U
239	0305208M	Distributed Common Ground/Surface Systems	07	2,100	2,100		2,100	12,867		12,867	U
240	0305208N	Distributed Common Ground/Surface Systems	07	44,571	44,571		44,571	46,150		46,150	U
241	0305220N	MQ-4C Triton	07	111,729	111,729		111,729	84,115		84,115	U
242	0305231N	MQ-8 UAV	07	26,518	26,518		26,518	62,656		62,656	U
243	0305232M	RQ-11 UAV	07	418	418		418	2,022		2,022	U
244	0305233N	RQ-7 UAV	07	716	716		716				U
245	0305234N	Small (Level 0) Tactical UAS (STUASL0)	07	5,071	5,071		5,071	4,835		4,835	U
246	0305239M	RQ-21A	07	9,497	9,497		9,497	8,899		8,899	U
247	0305241N	Multi-Intelligence Sensor Development	07	77,965	77,965		77,965	99,020		99,020	U
248	0305242M	Unmanned Aerial Systems (UAS) Payloads (MIP)	07	11,181	11,181		11,181	18,578		18,578	U
249	0305421N	RQ-4 Modernization	07	181,266	181,266		181,266	229,404		229,404	U
250	0308601N	Modeling and Simulation Support	07	4,709	4,709		4,709	5,238		5,238	U
251	0702207N	Depot Maintenance (Non-IF)	07	49,322	49,322		49,322	38,227		38,227	U
252	0708730N	Maritime Technology (MARITECH)	07	3,204	3,204		3,204	4,808		4,808	U
253	1203109N	Satellite Communications (SPACE)	07					37,836		37,836	U
9999	9999999999	Classified Programs		1,264,886	1,394,257		1,394,257	1,364,347	89,855	1,454,202	U
		Operational Systems Development		3,629,360	3,825,692		3,825,692	3,980,140	102,655	4,082,795	

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Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
254	0901560N	Continuing Resolution Programs	20		800,517	800,517	-42,576	-42,576		-42,576	U
		Undistributed			800,517	800,517	-42,576	-42,576		-42,576	
Total Research, Development, Test & Eval, Navy				18,333,041	18,076,818	18,376,384	35,747	163,447		163,447	

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Total Obligational Authority
(Dollars in Thousands)

Appropriation: 1319N Research, Development, Test & Eval, Navy

Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
254	0901560N	Continuing Resolution Programs	20	757,941	757,941		757,941				U
		Undistributed		757,941	757,941		757,941				
Total Research, Development, Test & Eval, Navy				18,112,565	18,539,831		18,539,831	17,675,035	130,365	17,805,400	

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Non RDT&E Title
(Dollars in Thousands)

Summary Recap of Budget Activities	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Research and Development	36,289						
Total Research, Development, Test & Evaluation	36,289						

Summary Recap of Non-RDT&E Title FYDP Programs

Mobility Forces	36,289
Total Research, Development, Test & Evaluation	36,289

Department of the Navy
FY 2018 President's Budget Request
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Non RDT&E Title
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Summary Recap of Budget Activities	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Research and Development					18,622		18,622
Total Research, Development, Test & Evaluation					18,622		18,622

Summary Recap of Non-RDT&E Title FYDP Programs

Mobility Forces					18,622		18,622
Total Research, Development, Test & Evaluation					18,622		18,622

Department of the Navy
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Non RDT&E Title
(Dollars in Thousands)

Appropriation: 4557N National Defense Sealift Fund

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
1	0408042N	National Defense Sealift Fund	04	36,289							U
		Research and Development		36,289							
Total National Defense Sealift Fund				36,289							

Department of the Navy
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Non RDT&E Title
(Dollars in Thousands)

Appropriation: 4557N National Defense Sealift Fund

Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
1	0408042N	National Defense Sealift Fund	04					18,622		18,622	U
		Research and Development						18,622		18,622	
Total National Defense Sealift Fund								18,622		18,622	

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Operational Nuclear Power Sys	0205675N	218	07	Volume 5 - 417
Operational Test & Eval Capability	0605865N	185	06	Volume 4 - 237
Other Helicopter Development	0604212N	97	05	Volume 3 - 19
P-3 Modernization Program	0604221N	102	05	Volume 3 - 101
Personnel, Trng, Sim, & Human Factors	0604703N	138	05	Volume 3 - 823
Power Proj Applied Research	0602114N	4	02	Volume 1 - 93

Program Element Title	Program Element Number	Line #	BA	Page
Power Projection Advanced Technology	0603114N	18	03	Volume 1 - 333
RDT&E Science & Tech Mgmt	0605861N	182	06	Volume 4 - 185
RDT&E Ship & Aircraft Support	0605863N	183	06	Volume 4 - 197
RQ-11 UAV	0305232M	243	07	Volume 5 - 905
RQ-7 UAV	0305233N	244	07	Volume 5 - 911
Radiological Control	0603542N	43	04	Volume 2 - 245
Rapid Technology Capability Prototype	0604320M	85	04	Volume 2 - 839
Rapid Technology Transition (RTT)	0203761N	202	07	Volume 5 - 81
SEW Architecture/Eng Support	0604707N	90	04	Volume 2 - 883
SSBN Security Tech Program	0101224N	199	07	Volume 5 - 47
SSN-688 & Trident Modernization	0604503N	125	05	Volume 3 - 573
Satellite Communications (Space)	0303109N	231	07	Volume 5 - 753
Ship Concept Advanced Design	0603563N	47	04	Volume 2 - 323
Ship Contract Design/ Live Fire T&E	0604567N	132	05	Volume 3 - 733
Ship Prel Design & Feasibility Studies	0603564N	48	04	Volume 2 - 351
Ship Self Def (Detect & Cntrl)	0604755N	140	05	Volume 3 - 845
Ship Self Def (Engage: Hard Kill)	0604756N	141	05	Volume 3 - 889
Ship Self Def (Engage: Soft Kill/EW)	0604757N	142	05	Volume 3 - 923
Shipboard Aviation Systems	0604512N	127	05	Volume 3 - 657

Program Element Title	Program Element Number	Line #	BA	Page
Small Business Innovative Research	0605502N	178	06	Volume 4 - 61
Small Diameter Bomb (SDB)	0604329N	118	05	Volume 3 - 441
Space & Elec War Surv/Recon	0605867N	187	06	Volume 4 - 253
Standard Missile Improvements	0604366N	119	05	Volume 3 - 459
Standards Development	0604215N	99	05	Volume 3 - 59
Strategic Sub & Wpns Sys Supt	0101221N	198	07	Volume 5 - 25
Strategic Technical Support	0605856N	181	06	Volume 4 - 177
Studies & Analysis Supt - Navy	0605152N	175	06	Volume 4 - 39
Submarine Acoustic War Dev	0101226N	200	07	Volume 5 - 49
Submarine Tactical Warfare Sys	0603562N	46	04	Volume 2 - 315
Submarine Tactical Warfare System	0604562N	131	05	Volume 3 - 717
Surface & Shallow Water MCM	0603502N	37	04	Volume 2 - 155
Surface ASW	0603553N	44	04	Volume 2 - 259
Surface ASW Cmbt Sys Integr	0205620N	215	07	Volume 5 - 347
Surface Combatant Cmbt Sys Eng	0604307N	116	05	Volume 3 - 405
Surface Ship Torpedo Defense	0603506N	38	04	Volume 2 - 215
Surface Support	0204228N	205	07	Volume 5 - 145
Tact Air Dir Infrared CM (TADIRCM)	0604272N	81	04	Volume 2 - 811
Tactical Aim Missiles	0207161N	225	07	Volume 5 - 723

Program Element Title	Program Element Number	Line #	BA	Page
Tactical Airborne Reconnaissance	0603261N	35	04	Volume 2 - 93
Tactical Command System	0604231N	104	05	Volume 3 - 119
Tactical Command System - MIP	0304231N	167	05	Volume 3 - 1439
Tactical Cryptologic Systems	0304785N	168	05	Volume 3 - 1443
Tactical Data Links	0205604N	214	07	Volume 5 - 305
Tactical Unmanned Aer Vehicles	0305204N	237	07	Volume 5 - 829
Target Systems Development	0604258N	172	06	Volume 4 - 15
Technical Information Services	0605804N	179	06	Volume 4 - 101
Test & Evaluation Support	0605864N	184	06	Volume 4 - 209
Threat Simulator Development	0604256N	171	06	Volume 4 - 1
Tomahawk Mssn Planning Ctr	0204229N	206	07	Volume 5 - 159
Training System Aircraft	0603208N	96	05	Volume 3 - 1
USMC Intelligence/Electronics Warfare Sys	0206625M	223	07	Volume 5 - 671
Undersea Warfare Advanced Tech	0603747N	26	03	Volume 1 - 461
Undersea Warfare Applied Res	0602747N	12	02	Volume 1 - 243
University Research Initiatives	0601103N	1	01	Volume 1 - 1
V-22A	0604262N	108	05	Volume 3 - 245
Warfare Support System	0604230N	103	05	Volume 3 - 105
Warfighter Protection Adv Tech	0603729N	25	03	Volume 1 - 455

Program Element Title	Program Element Number	Line #	BA	Page
Warfighter Sustainment Applied Res	0602236N	8	02	Volume 1 - 179

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601103N *I University Research Initiatives*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	140.998	101.714	118.130	-	118.130	120.233	118.388	118.397	120.765	Continuing	Continuing
0000: *University Research Initiatives*	0.000	112.033	101.714	118.130	-	118.130	120.233	118.388	118.397	120.765	Continuing	Continuing
9999: *Congressional Adds*	0.000	28.965	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.965

A. Mission Description and Budget Item Justification

This program includes support for multidisciplinary basic research in a wide range of scientific and engineering disciplines that enable the U.S. Navy to maintain technological superiority, and for university research infrastructure to acquire research instrumentation needed to maintain and improve the quality of university research important to the Navy. Multidisciplinary University Research Initiative (MURI) efforts involve teams of researchers investigating high priority topics and opportunities that intersect more than one traditional technical discipline. For many military problems this multidisciplinary approach serves to stimulate innovation, accelerate research progress and expedite transition of results into Naval applications. The Defense University Research Instrumentation Program (DURIP) supports university research infrastructure essential to high quality, Navy-relevant research. The instrumentation program complements other Navy research programs by supporting the purchase of high cost research instrumentation that is necessary to carry out cutting-edge research. The program supports Presidential Early Career Awards for Scientists and Engineers (PECASE), single investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This program provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national security.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	146.196	101.714	120.481	-	120.481
Current President's Budget	140.998	101.714	118.130	-	118.130
Total Adjustments	-5.198	0.000	-2.351	-	-2.351
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-5.198	0.000			
• Program Adjustments	0.000	0.000	-2.351	-	-2.351
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601103N *I University Research Initiatives*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	28.965	0.000
Congressional Add Subtotals for Project: 9999	28.965	0.000
Congressional Add Totals for all Projects	28.965	0.000

Change Summary Explanation

The FY 2017 funding request was reduced by -$12.4 million as required for the Department of the Navy to comply with the Bipartisan Budget Act of 2015.

The funding increase from FY 2017 to FY 2018 reflects additional DURIP, MURI, and PECASE awards.

Technical: N/A

Schedule: N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601103N / *University Research Initiatives*	Project (Number/Name) 0000 / *University Research Initiatives*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *University Research Initiatives*	0.000	112.033	101.714	118.130	-	118.130	120.233	118.388	118.397	120.765	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project includes support for multidisciplinary basic research in a wide range of scientific and engineering disciplines that are important for maintaining the technological superiority of the U.S. Navy, and for university research infrastructure to acquire instrumentation needed to maintain and improve the quality of university research important to the Navy. MURI efforts involve teams of researchers investigating high priority topics that intersect more than one traditional technical discipline. For many military problems this multidisciplinary approach serves to stimulate innovation, accelerate research progress, and expedite transition of results into Naval applications. The DURIP project supports university research infrastructure essential to high quality, Navy-relevant research. The instrumentation project complements other Navy research programs by supporting the purchase of high cost research
instrumentation that is necessary to carry out cutting-edge research. The PECASE project supports single-investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This project provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national
security.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: DEFENSE UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM (DURIP)	21.317	20.557	23.022	0.000	23.022
Description: DURIP funds are provided to universities to purchase relatively high cost research instrumentation that is normally not included in single-investigator type research grants. Individual grants range from $50K to $1.5M. The DURIP program is an Office of the Secretary of Defense (OSD) interest item and OSD directs that funding for the DURIP efforts be awarded after OSD announces the awardees, which typically takes place towards the second half of the fiscal year. In turn, universities need to purchase the instrumentation and take delivery before any billings are generated. It frequently takes several months for delivery and billing to be completed. DURIP is a one year program. The FY 2018 increase reflects an additional number of DURIP awards. ***FY 2016 Accomplishments:*** - Continued competition for research instrumentation awards to universities. ***FY 2017 Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601103N / *University Research Initiatives*	**Project (Number/Name)** 0000 / *University Research Initiatives*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue to support university research infrastructure essential to high-quality naval-relevant research. ***FY 2018 OCO Plans:*** N/A					
Title: MULTIDISCIPLINARY UNIVERSITY RESEARCH INITIATIVE (MURI) ***Description:*** Research efforts include high priority topics that intersect more than one traditional discipline. MURI topics are selected to address Naval Science and Technology (S&T) Focus Areas as described in the Naval S&T Strategic Plan. The MURI program is an OSD interest item and OSD directs that funding for the MURI efforts be awarded after OSD announces the awardees, which typically takes place towards the second half of the fiscal year. Since the MURI program funds academic researchers, execution of the efforts typically ramps up during the summer academic break months. MURI projects make significant contributions to Navy and DoD objectives by; speeding up scientific programs by cross-fertilization of ideas, hastening the transition of basic research to practical applications, and training students in cross-disciplinary approaches to science and engineering research of importance to DoD. MURI is a five year program. The FY 2018 increase reflects an additional number of MURI awards. ***FY 2016 Accomplishments:*** - Continued competition for new MURI awards to address selected high priority Naval S&T areas, transformational initiatives, and grand challenges, including strategically important DoD research areas. Approximately eight high priority research topics will be identified for publication in a BAA to solicit proposals. - Continued MURI projects begun in prior years. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue to support teams of researchers investigating high priority topics and opportunities that intersect more than one traditional technical discipline ***FY 2018 OCO Plans:***	82.039	73.416	86.438	0.000	86.438

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601103N / *University Research Initiatives*	**Project (Number/Name)** 0000 / *University Research Initiatives*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: PRESIDENTIAL EARLY CAREER AWARDS (PECASE) ***Description:*** PECASE awards are made to academic scientists early in their research careers for extremely prestigious, single-investigator research in areas of vital importance to the Navy. Awards provide national recognition and research grants of up to $200K per year for five years. OSD, with policy and oversight responsibility for the PECASE program, directed that the number of PECASE awards be set at four new awards per year. PECASE is a five year program. The FY 2018 increase is to provide additional funding to ongoing PECASE research awards. ***FY 2016 Accomplishments:*** - Selected six outstanding university researchers to receive the five-year PECASE research award to conduct research of importance to the Navy. - Continued PECASE programs begun in earlier years. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, and award four new awards per OSD guidance. ***FY 2018 Base Plans:*** Continue to award four new awards per OSD guidance for recognizing and honoring extraordinary achievements of young professionals at the outset of their independent research careers in Science and Technology ***FY 2018 OCO Plans:*** N/A	8.677	7.741	8.670	0.000	8.670
Accomplishments/Planned Programs Subtotals	112.033	101.714	118.130	0.000	118.130

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601103N / *University Research Initiatives*	**Project (Number/Name)** 0000 / *University Research Initiatives*

E. Performance Metrics

This University Research Initiative seeks to improve the quality of defense research conducted by universities and supports the education of engineers and scientists in disciplines critical to national defense needs. The initiative is a collection of specialized research programs performed by academic research institutions. Individual project metrics are tailored to the needs of specific applied research and advanced development programs. Example metrics include extending the life of Thermal Barrier Coatings for transition to the Enterprise and Platform Enablers Future Naval Capability program. It is projected that the life time of Thermal Barrier Coating on Turbine Blades can be doubled. The National Research Council of the National Academies of Science and Engineering's Congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601103N / *University Research Initiatives*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	28.965	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.965

A. Mission Description and Budget Item Justification

This congressional increase furthers the Navy's efforts to support multidisciplinary basic research in a wide range of scientific and engineering disciplines that enable the U.S. Navy to maintain technological superiority. Through this increase, additional Multidisciplinary University Research Initiative (MURI), Defense University Research Instrumentation Program (DURIP) and Presidential Early CareerAwards for Scientists and Engineers (PECASE) will be selected and funded.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	28.965	0.000
FY 2016 Accomplishments: - Expanded the competition for new Multidisciplinary University Research Initiative (MURI) awards to address selected high priority Naval S&T areas, transformational initiatives, and grand challenges, including strategically important DoD research areas. - Expanded the competition for new Defense University Research Instrumentation Program (DURIP) awards to universities. - Funded an outstanding university researcher in receiving the five-year Presidential Early Career Award for Scientists and Engineers (PECASE) research award to conduct research of importance to the Navy.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	28.965	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This University Research Initiative seeks to improve the quality of defense research conducted by universities and supports the education of engineers and scientists in disciplines critical to national defense needs.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601152N / *In-House Lab Independent Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	18.978	18.508	19.438	-	19.438	19.434	19.440	19.441	19.829	Continuing	Continuing
0000: *In-House Lab Independent Res*	0.000	18.978	18.508	19.438	-	19.438	19.434	19.440	19.441	19.829	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority by providing new technological concepts for the maintenance of Naval power and national security, and by helping to avoid scientific surprise while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNCs). The Department of the Navy (DON) component responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements and is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command. It enables technologies that significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. The In-house Laboratory Independent Research (ILIR) program also adds increased emphasis to the revitalization of the scientist and engineer workforce component at the Navy's Warfare Centers and Laboratories by attracting superior candidates and retaining our best members through the provision of exciting and meaningful work.

This PE addresses DON Basic Research, which includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental, and life sciences, and is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in thirteen research focus areas: Power and Energy; Operational Environments; Maritime Domain Awareness; Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Distributed Operations; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; Affordability, Maintainability and Reliability.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for: basic research to support the execution of their assigned missions; developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems; promoting hiring and development of new scientists; and encouragement of collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

In-house Laboratory Independent Research (ILIR) efforts are selected by Naval Warfare Centers/Lab Commanding Officers and Technical Directors near the start of each Fiscal Year through internal competition. Efforts typically last three years, and are generally designed to assess the promise of new lines of research. Successful efforts attract external, competitively awarded funding. Because the Warfare Centers and Labs encompass the full range of naval technology interests, the scope of ILIR topics roughly parallels that of PE 0601153N, Defense Research Science.

Due to the number of efforts in PE 0601152N, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 1: *Basic Research*			R-1 Program Element (Number/Name) PE 0601152N / *In-House Lab Independent Res*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	19.126	18.508	19.438	-	19.438
Current President's Budget	18.978	18.508	19.438	-	19.438
Total Adjustments	-0.148	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.148	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601152N / *In-House Lab Independent Res*	Project (Number/Name) 0000 / *In-House Lab Independent Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *In-House Lab Independent Res*	0.000	18.978	18.508	19.438	-	19.438	19.434	19.440	19.441	19.829	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project sustains U.S. Naval S&T superiority, provides new technological concepts for the maintenance of naval power and national security, and mitigates scientific surprises, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNC's). It responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements. It is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command (NWDC) and the Marine Corps Combat Development Command (MCCDC), and enables technologies that significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for basic research to support the execution of their assigned missions, for developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to naval problems, to promote hiring and development of new scientists, and to encourage collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)	16.528	16.065	16.873	0.000	16.873
FY 2016 Accomplishments: Continued FY 2015 ILIR projects that are intended to be approximately three years in length to research topics including: Structural materials, functional materials, maintenance reduction, hydrodynamics, power generation, energy conservation and conversion, littoral geosciences, optics, and biology; marine mammals; ocean acoustics; and autonomous systems. - Continued research for polymer materials to understand improved helmet blast protection. - Continued fundamental research for composite materials for reduced signature for undersea vehicles. - Continued research for the fundamental understanding of graphene type Radio Frequency (RF) Antennas. - Continued research for complex unmanned sensor networks. - Continued fundamental research for the understanding of optimization of undersea sensor distribution in littoral environments. - Continued research for understanding effects of energetic materials under high pressure environment. - Continued research on Operational Fatigue of Warfighters due to Stress Environments. - Continued research on Human Gesture and Computer Interface and Functionality.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601152N / *In-House Lab Independent Res*	**Project (Number/Name)** 0000 / *In-House Lab Independent Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research framework for Efficient Quantum Computing. - Continued research for Autonomous Routing of Unmanned Vehicles. - Continued fundamental research for undersea imaging and analysis. - Continued research for modeling super-cavitation of Advanced Propulsor Designs. - Continued research for Predictive Performance Modeling of Advanced Naval Hull Designs. - Continued research for Design and Performance of High Speed Naval Vessels. - Continued research for Advanced Smart Wireless Cooperative Vehicular Network. - Continued research for Undersea Laser Communication and Identification in Littoral Environments. - Sensing, diagnostics, and detectors; navigation and timekeeping; nano electronics; real time targeting, Electro-Optical/InfraRed (EO/IR) electronics; EO/IR electronic warfare; and EO/IR sensors for surface and subsurface surveillance. - Undersea weaponry, energetic materials and propulsion, directed energy, and TeraHertz Time-Domain Spectroscopy (THz-TDS) technology that addresses overseas contingency operations and Counter Improvised Explosive Device (C-IED) detection by detecting and spectroscopically identifying military and home-made explosives and formulations. - Biosensors, biomaterial, bioprocesses; marine mammals; casualty care management, undersea medicine; human factors and organizational design; manpower, personnel and advanced cockpit; and operational training and education. These efforts are coordinated with the Navy Medical Research Center (NMRC). - Mathematical foundation and computational theory and tools for design communications, decision support theory, algorithm and tools, information assurance, secure and reliable infrastructure for command and control, mathematical optimization for optimal resource allocation and usage, modeling and computational propagation, seamless, robust connectivity and networking and cyber warfare. - Novel hull forms, materials, structures and signatures; and virtual shaping concepts for structures and platforms. - Littoral geosciences, optics, and biology; marine mammals; ocean acoustics; and autonomous systems. - Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering. - Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. - Command and Control and connectivity research.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601152N / *In-House Lab Independent Res*	**Project (Number/Name)** 0000 / *In-House Lab Independent Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated FY 2016 ILIR projects that are intended to be approximately three years in length to research topics including : - Structural materials, functional materials, maintenance reduction, hydrodynamics, power generation, energy conservation and conversion. - Novel hull forms, materials, structures and signatures; and virtual shaping concepts for structures and platforms. - Littoral geosciences, optics, and biology; marine mammals; ocean acoustics; and autonomous systems. - Tailoring Instruction to the Individual: Investigating the Utility of Trainee Aptitudes for use in Adaptive Training. - Research to Improve Situational Awareness Using Learned Representations and Autonomous Systems. - Developing Novel Propellants for Solid Ramjet Application. - Anomalous Capacity Loss and Recovery in Lead Acid Batteries Following Rapid Pulsed Discharge Power and Energy. - Research of n+InP as a Possible New Semiconductor Material for Fast Neutron Spectroscopy. - Polarimetric Radar Cross Section Control. - Broadband Prewhitening Filtering Framework to Improve Beamforming Detection Performance inLinear Arrays under reduced Snapshot Support Conditions. - Automated Storytelling: Co-clustering of Topic Models for Topic Detection and Tracking - Developing the Theory of Superabsorption. - Topological Methods for the Analysis of Big Data. - Neutralization Using Air-Deployable Self-surveying UUV - Optimized Waterspace Management & Scheduling for Heterogeneous Teams of Autonomous Vehicles. - Secure Underwater Communications Study for the Advanced Undersea Weapons (AUWS). - Acoustic Reception and Transmission in High Speed Flows. - Beamforming with Arrays of Sensor Elements with Uncertain Location. - Develop Design, Testing, and Analysis of Zero Poisson Ratio Metamaterials - Beam Space Multiple Input Multiple Output. - Graphene Broadband Infrared Light-Emitting Devices. - Machine Learning of Autonomous Vehicle Tactics through Human Evaluation. - Nomad: A Hybrid-Cloud Aware High Assurance and Availability Cloud Service. - Nonvolatile and Cryogenic Compatible Quantum Memory Devices. - Stochastic Compiler Hacks as Software Immunization Mechanisms (SCHSIM).					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601152N / *In-House Lab Independent Res*	**Project (Number/Name)** 0000 / *In-House Lab Independent Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Energy Harvesting for Future E					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Continue ILIR projects started in FY 2016. - Complete FY 2015 ILIR projects which were three years in duration. - Initiate FY 2017 ILIR projects that are to be approximately three years in length. - Construct Correspondence of Physiological and Subjective Measures of Hypoxia - Development and Validation of a Dynamic Environmental Severity Index (d-ESI) Metric - Electrodeposition of Aluminum Alloys from Air-stable - Microfocus Computed Tomography Research - Quantum Synchronization of Unequal Clocks; Sensors and Electronics - Verification of Carrier-based Autonomous Systems (VOCAS) - Development of Multifunctional ZnO Nanocarriers for Controlled and Enhanced Biofilm Dispersion - Decrements in Skeletal Muscle Performance & Mitochondrial Function - Development of a Novel Bacteriophage Therapeutic Treatment Against Methicillin Resistant Staphylococcus aureus (MRSA) and Multi-Drug Resistant Pseudomonas Aeruginosa - Impact of Physiological Adaptations Associated with Diving on Blood and Tissue Dosimetry of Xenobiotics - Surface Chemistry Evolution in High-power/High-energy Lithium-ion Battery (LIB) Cathodes - Performance Improvement in Iron Fluoride Conversion Materials Through Copper Doping - Dynamically Driven Modal Effects on Load Combinations that Affect Failure on Multi-Hull Structures - Development of Multifunctional Materials with Reconfigurable Electromagnetic Properties - Active Flow Control by Sweeping Jets - Algorithm Design for Mixed-Radix Polynomial Arithmetic - Applications of the Aharonov Ansatz to Sensor Problems - Catalytic Self-Decontaminating Cloth Prepared Through Self-Assembly - Fault Tolerant Methods for Scientific Computing - Hypersonic, Dissociating Flow Over an Elastically Deforming Airfoil at Sea-Level - Theoretical Foundations of System Engineering - Mechanistic and Kinetic Investigations of the Combustion of Reactive Materials via Time-Resolved - Microscale Modeling of Multiphase Interactions in Energetic Systems - High-Density Metal Binder Compositions for Hard-Target Defeat - Fluid Structure Interaction Numerical Modeling					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601152N / *In-House Lab Independent Res*	**Project (Number/Name)** 0000 / *In-House Lab Independent Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Unsupervised Image and Data Analysis - Seawater Flow in Electric and Magnetic Fields - Optimal UUV Design for Energetic Environments - 3D Reconstruction From Similarity Matrices - Hull; A Higher Order Shear Deformation Model of a Curved Beam - Observer Modeling Approach to Understanding Decision Making in Submarine Operations - Constitutive Laws for the Design of Metallic Foams - Cooperative Search in Autonomous Swarms with Restricted Communication - Field Programmable Neural Array for Neural Information Processing of Underwater Sensing Applications - Frequency-varying Dielectric Composites - Investigation of Transduction Physics of Distributed Fiber Sensor Systems Embedded in a Fully Elastic medium - Lift Production Using Differential Cavity Ventilation on a Symmetric Hydrofoil - Multi-level Linear Algebra; Information and Decision Support - Observation and Modeling of Natural Collective Behavior; Autonomous Systems - Theory of Nearfield Spherical Antenna Measurements Over Seawater - Undersea Acoustic Superiority - Short Pulse Laser Induced Plasma Filaments for Extended Covert Communications - Voltage-Tunable Wavelength-Agile 2D-Material-Based Light Emitting Diodes ***FY 2018 Base Plans:*** Continue In-house Laboratory Independent Research (ILIR) projects that enables laboratories to sponsor focused, high-risk research with potential high payoffs to the Navy and Marine Corps on a discretionary basis. ***FY 2018 OCO Plans:*** N/A					
Title: SCIENCE TECHNOLOGY ENGINEERING AND MATH (STEM) EFFORTS AT NAVY LABS ***Description:*** This effort will support both the Science and Engineering Apprenticeship Program (SEAP) and the Naval Research Enterprise Intern Program (NREIP) summer programs to encourage participating students to pursue science and engineering careers, to further their education via mentoring by laboratory personnel and their participation in research, and to make them aware of DON research and technology efforts, which can lead to employment within the DON. Participating students will spend eight to ten weeks during the summer doing research at approximately 19 to 20 DON laboratories. Participants will receive a stipend distributed by the Contractor. The stipend is a monthly allowance paid to interns for their participation in the research efforts.	2.450	2.443	2.565	0.000	2.565

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FY 2016 Accomplishments: - Continued Naval Research Enterprise Intern Program (NREIP) to support undergraduate and graduate students performing Navy-related research at Naval Warfare Centers under the supervision and mentorship of DON Scientists, thus exposing them to interesting and challenging work done at the centers. NREIP is a continuing Navy education program. - Continued Science and Engineering Apprenticeship Program (SEAP) supporting high school student programs. - Continued Science, Technology, Engineering and Mathematics (STEM) projects that are intended to be approximately three years in length. Projects selected for STEM funding will focus on engaging and educating future Naval scientists and engineers and incorporating naval relevance, diversity, and STEM best practices. These efforts complement and support the ongoing independent research, education and outreach efforts taking place at the naval laboratories. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue to provide opportunities for students to participate in research at DON laboratories during the summer via the Naval Research Enterprise Internship Program (NREIP) program for undergraduate and graduate students and the Scientist and Engineering Apprenticeship Program (SEAP) Program for high school students. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	18.978	18.508	19.438	0.000	19.438

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601152N / *In-House Lab Independent Res*	**Project (Number/Name)** 0000 / *In-House Lab Independent Res*

E. Performance Metrics

The ILIR initiative seeks to improve the quality of defense research conducted predominantly through the Naval Warfare Centers/Laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered environment since it is basic research, but many projects focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing systems. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. The National Research Council of the National Academies of Science and Engineering's Congressionally directed "Assessment of Department of Defense Basic Research" concluded that the Department of Defense is managing its basic research program effectively.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601153N *I Defense Research Sciences*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	488.666	422.748	458.333	-	458.333	469.934	467.628	468.910	478.210	Continuing	Continuing
0000: *Defense Research Sciences*	0.000	435.563	422.748	458.333	-	458.333	469.934	467.628	468.910	478.210	Continuing	Continuing
9999: *Congressional Adds*	0.000	53.103	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	53.103

A. Mission Description and Budget Item Justification

This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy approved by the S&T Corporate Board
(20 Jan 2015). This new strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs).

This PE addresses basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach).

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), fields upon which a wide range of fundamental Naval capabilities depend. There are currently five NNRs.

S&T investment in basic research also includes the Basic Research Challenge Program which was established to competitively select and fund promising research programs in new areas not addressed by the current basic research program. The Basic Research Challenge Program stimulates new, high-risk basic research projects in multi-disciplinary and collaborative departmental efforts, and funds topics that foster leading edge science that attract new principal investigators and organizations. Basic Research Challenge awards are for a period of four years.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	506.553	422.748	460.050	-	460.050
Current President's Budget	488.666	422.748	458.333	-	458.333
Total Adjustments	-17.887	0.000	-1.717	-	-1.717
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-6.070	0.000			
• SBIR/STTR Transfer	-11.817	0.000			
• Program Adjustments	0.000	0.000	-1.717	-	-1.717
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	53.103	0.000
Congressional Add Subtotals for Project: 9999	53.103	0.000
Congressional Add Totals for all Projects	53.103	0.000

Change Summary Explanation

The FY 2017 request was reduced by -$34.9 million as required for the Department of the Navy to comply with the Bipartisan Budget Act of 2015.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*	Project (Number/Name) 0000 / *Defense Research Sciences*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Defense Research Sciences*	0.000	435.563	422.748	458.333	-	458.333	469.934	467.628	468.910	478.210	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy. This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs).

This PE addresses basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support. Activities in this area also support maintenance of the Science and Engineering Workforce and STEM Education and Outreach.

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), S&T areas that are uniquely important to maintaining U.S. Naval superiority. With the designation in 2011 of Sea-Based Aviation as an NNR, there are currently five NNRs.

S&T investment in basic research also includes the Basic Research Challenge program which was established to competitively select and fund promising research programs in new areas not addressed by the current basic research program. The Basic Research Challenge Program stimulates new, high-risk basic research projects in multi-disciplinary and collaborative departmental efforts, and funds topics that foster leading edge science that attract new principal investigators and organizations. Basic Research Challenge awards are for a period of four years.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: AIR, GROUND AND SEA VEHICLES	53.999	52.065	57.160	0.000	57.160
Description: Efforts include research in surface/subsurface reduced signatures; free-surface, subsurface, and propulsor hydromechanics; hull life assurance; advanced ship concepts; distributed intelligence for automated survivability; advanced electrical power systems; air vehicles; air platforms propulsion and power; air platforms					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
survivability and signature control; special aviation projects; Unmanned Air Vehicle/Unmanned Combat Air Vehicle (UAV/UCAV); environmental quality; logistics; power generation, energy conversion, and storage; and advancements in naval technology innovations. Funding increase in 2018 is the result of several increased Department Research Initiatives in the areas of Science of Autonomy, Advanced Naval Power Systems, and Advanced Sea Platform Performance. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Air Vehicles - Continued investigations into controlled initiation and recovery from aggressive, non-linear aero-maneuvers conducted by unmanned air vehicles. - Continued university research in rotorcraft technology areas such as tilt rotor aeromechanics, rotor flow field/ ship air wake coupling during shipboard operations, flight simulation of advanced ducted fan air vehicles, active rotor control for enhanced shipboard operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications. - Continued research in computational simulation of rotorcraft operations in a shipboard environment. - Continued investigation of advanced structural concepts, providing a high degree of crew protection during crashes. - Continued research into new analytical methods for high-fidelity prediction of rotorcraft performance, loads, and vibration. - Continued university and Navy laboratory research in basic rotorcraft science with emphasis on enabling concepts for variable geometry/variable rotor-speed aircraft. - Continued Sea-Based Aviation NNR research in Virtual Dynamic Interface, Advanced Manned/Unmanned Handling Qualities and Control for Naval Operations, Improved Fixed Wing Launch and Recovery High Lift Aerodynamics and Performance, Enhanced Fixed Wing V/STOL Operations, and Autonomous Deck Operations. Science of Autonomy - Continued multi-disciplinary research into the science of autonomy, including multi-vehicle collaboration, intelligence, and human interaction. - Continued research in scalable and robust distributed collaboration among autonomous systems. - Continued research in human/unmanned system collaboration. - Continued research in autonomous perception and intelligent decision-making.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research in intelligent architectures for autonomous systems. - Continued research in integrated design analysis/prognosis to optimize airframe structural properties and match material selection to operational requirements. - Continued modeling of complex behaviors/interactions to predict risk, probability and mechanism of failure and forecast lifetime performance. Ship Concepts and Hydrodynamics - Continued modeling and optimization techniques for naval design of multi-hulls, optimal functional arrangements for both ship and submarine design, and optimization for semi-displacement craft. - Continued implementation of nationwide program to increase interest in naval engineering education. - Continued further examination of computational mechanics to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis and error control. - Continued research in propeller tip vortex cavitation and sheet-to-cloud cavitation. - Continued computational and experimental investigation into complex, three-dimensional flow separation problems. - Continued modeling and understanding of full-scale circulation control bow planes design. - Continued validation of Unsteady Reynolds Averaged Navier Strokes (URANS) prediction on maneuvering effects on ship motion in waves. - Continued modeling of hydro-acoustics of advanced materials propulsor. - Continued program to investigate renewable energy technologies for Navy applications. - Continued computational and experimental investigations of wakes in stratified fluids. - Continued Large Eddy Simulation (LES) modeling of crashback of underwater vehicle with propulsor. - Continued measurement and modeling of unsteady high-speed craft hydrodynamics. - Continued high-fidelity fluid-structure interaction program. - Continued computational prediction and validation of damaged ship maneuvering. - Continued research efforts on multi objective optimization of hull shapes using hybrid hull concepts to achieve high efficiency, reduced slamming loads and hydrodynamic/structural performance. - Continued development of the understanding of shockwave propagation and failure mechanisms of high strain rate, sensitive polymers and their interaction in composites with structural and armor materials. - Continued research into the extension of bubble-wake modeling to physical far-field regime. Ship Signatures, Structures, and Materials - Continued the structural performance of hybrid ship hulls and hybrid joints subject to sea loads and weapons effects for application to high speed, low signature vessels.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued modeling of alternating current sources and propagation. - Continued Particle Image Velocimetry (PIV)/Laser Doppler Velocimetry (LDV) studies of multiphase bubble flows and interaction with elastic plates in a small, quiet water tunnel. - Continued LDV of scaling effects studies of unsteady elastic duct and propulsor interaction in a wind tunnel. - Continued pressure-shear experiments at ultra-high loading rates of Explosion Resistant Coating (ERC) in combination with light weight composites, including glass, acrylics, Poly(methyl methacrylate) (PMMA) and development of computational simulation capability for understanding the behavior and failure effect of ERC on the materials. - Continued computational methods for simulation of fragmentation, including tracking interactions of fragments and their interactions with composites of various materials (and fluid fragment interaction). - Continued effort on much higher strain rate loading and constitutive behavior of ERC for strain rates appropriate to ballistic events. - Continued work on cohesive elements for dynamic fracture under combined mode for application to failure in joints in ship structures under blast loading. - Continued work on hybrid ship (non-magnetic stainless steel/composite) hull concepts. - Continued further examination of computational mechanics in order to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis, and error control. - Continued concept for development of photonic band gap waveguide. - Continued developing methods to model the mechanisms of interaction between an elastic duct wall and fluid-flow in a duct with a propeller. - Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures. - Continued efforts developing alternative hull approaches for fast ships and hybrid ship hull structures. - Continued efforts to develop a better understanding of explosion resistant coating under extreme loads and its interaction with other armor and structural materials. - Continued investigation into methods to control airborne noise transmission using active control methods. - Continued development of metamaterial concepts for radio frequency (RF) signature control and photonic and acoustic applications. - Continued experimental facility development for sea-slamming loads in fast ships, and consideration for hydro-elasticity and structural details in composites panels and scale effects to support measurements used to develop new theoretical models. - Continued performing measurements of sea-slamming loads in fast ships at various sea states and speeds for composite panels on the experimental facility and developed/verified theoretical/computational models considering hydro elasticity and structural details and scale effects.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued study of droplet & volume scattering phenomena. - Continued the development of predictive models for infrared emission and reflection from breaking waves. - Continued development of computational electromagnetic tools for electromagnetic materials design & optimization. - Continued development of a methodology for highly reliable composite to metallic joints. - Continued fundamental efforts in multi-scale, time-varying, hull structural reliability models and processes for structural performance analysis. - Continued the development and understanding of elastomeric polymers for multi-functionality in protection systems/armor and structural acoustics, with superior properties against environmental effects and extreme temperature. - Continued development of advanced electromagnetic energy absorbing composite materials. - Continued efforts to further the physics based understanding of structural acoustics for the next generation submarine. - Continued improvements for predictive capabilities of surface ship propulsion systems and underwater acoustic signatures. - Continued Sea-Based Aviation NNR structures and materials research in Structural Mode Characterization, High-Loading/Lightweight Materials, Advanced Structural Concepts, Material Degradation/Corrosion, and Structural Protection and Maintenance. Ship and Air Platform Machinery and Systems - Continued efforts to understand and control the generation and propagation of far-field jet noise. - Continued development of Pulsed Detonation Engine (PDE) Technology. - Continued development and understanding of control capabilities and distributed intelligence strategies for shipboard systems. - Continued propulsion system cost-reduction efforts through vibration reduction, noise and thermal fluctuation at the source by controlling combustion. - Continued passive and active high speed noise control. - Continued studies of alternate propulsion systems for PDE and generated prediction models. - Continued investigation of thermal management approaches for cooling high power electronic devices. - Continued research on non-vapor, compression based refrigeration cycles. - Continued studies of advanced air-breathing propulsion concepts. - Continued study of advanced materials for PDE applications. - Continued efforts to expand the model based reasoning control algorithm approach to multiple heterogeneous systems.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued studies of complexity in heterogeneous distributed control systems. - Continued efforts to investigate a market based control approach to distributed control. - Continued efforts to perform physics based modeling of fluid actuation systems. - Continue Sea-Based Aviation NNR propulsion research in Propulsion Cycles, Subsystems, and Integration, Turbomachinery and Drive Systems with Enhanced Maintainability, Jet Noise Reduction, Hot Section Materials and Coatings, and Small UAV Propulsion. Generation, Energy Conversion and Storage - Continued evaluation of stability and control of electrical power systems. - Continued analyzing synchronization of 19 diode lasers to produce intense beams. - Continued efforts in nanostructures, novel electrolytes, and electrode materials to enable new, 3D, power source architectures and to improve the safety and capacity of rechargeable lithium and lithium-ion batteries. - Continued exploration and development of materials for high energy density, passive power electronics (Capacitors). - Continued expanding the fundamental understanding of direct electrochemical oxidation and the use of logistic fuels in solid oxide fuel cells. - Continued development of phase change cooling approaches for high power electronic devices. - Continued efforts developing a science base for optimized combustion of alternative fuels. - Continued the investigation of the long-term durability effects of coating/substrate systems from combustion chemistries and products derived from current petroleum-based fuel and from petroleum-based/synthetic fuel blends that lead to predictive models. - Continued effort in energy and power management to include understanding and reliability of high power electronics. - Continued investigation into rare earth-free permanent magnet materials. - Continued investigating thermodynamic cycle analogy for harvesting waste heat using multiferroic (pyromagnetic & pyroelectric) materials. - Continued research into thermionic energy conversion using inter-gap molecular species in a heat cell with low work function materials. - Continued research into cyber-physical, real-time distribution and control of power & energy networks, physics-based models, hardware-in the-loop simulation. - Continued development of novel approaches to deposition of ultra-high quality SiC epilayers needed to enable high voltage, high frequency, high-power wide bandgap semiconductor devices. - Continued study of fault tolerant electromechanical energy converter concepts for naval applications.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research to understand new energy conversion methods (pyroelectrics, thermionics, and combustion). - Continued basic research in next generation wide bandgap semiconductors. - Continued experimental and computational investigation of dynamic response of marine gas turbines for on-demand and flexible power supply. - Continued power and energy management science, particularly understanding new magnetic materials and sliding electrical contacts. - Continued fundamental research in novel, high temperature superconducting (HTS) material synthesis. Advancements in Naval Technology Innovations - Continued development of the Centers for Innovative Naval Technology (CINT), which will expand and apply the Center for Innovative Ship Design (CISD) approach to other Navy facilities to dramatically expand participation and the breadth of naval technologies covered.					
FY 2017 Plans: Air Vehicles - Continue all efforts of FY 2016, less those noted as completed above. Science of Autonomy - Continue all efforts of FY 2016, less those noted as completed above. Ship Concepts and Hydrodynamics - Continue all efforts of FY 2016, less those noted as completed above. - Complete modeling and optimization techniques for naval design of multi-hulls, optimal functional arrangements for both ship and submarine design, and optimization for semi-displacement craft. Ship Signatures, Structures, and Materials - Continue all efforts of FY 2016, less those noted as completed above. - Complete work on hybrid ship (non-magnetic stainless steel/composite) hull concepts. - Complete efforts developing alternative hull approaches for fast ships and hybrid ship hull structures. Ship and Air Platform Machinery and Systems - Continue all efforts of FY 2016, less those noted as completed above.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Power Generation, Energy Conversion and Storage - Continue all efforts of FY 2016, less those noted as completed above. Advancements in Naval Technology Innovations - Continue all efforts of FY 2016, less those noted as completed above. ***FY 2018 Base Plans:*** Air Vehicles Basic research investments include fixed-wing, rotary wing, and vertical/short takeoff and landing (V/STOL) aircraft, ship/aircraft dynamic interface, air vehicle management, and control, aerodynamics, and aeromechanics. Additional research investments include airframe structures and materials science address durability, service life, readiness, affordability, and future capabilities development. Most airframe challenges are not platform or design specific; they are fully represented in both current new-build and planned next-generation platform designs. Additional areas of research include metallic structures and materials, composite structures and materials, and advanced concepts related to: design, failure analysis, materials selection, fabrication, and sustainment of air-vehicle structures. Conducting university research supports rotorcraft technology areas such as tilt rotor aeromechanics, rotor flow field/ship air wake coupling during shipboard operations, flight simulation of advanced ducted fan air vehicles, active rotor control for enhanced shipboard operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications. Continuing Sea-Based Aviation National Naval Responsibility (NNR) research in Virtual Dynamic Interface (VDI), advanced manned/unmanned handling qualities and control for Naval operations, improved fixed wing launch and recovery high lift aerodynamics and performance, Enhanced fixed wing V/STOL operations, and autonomous deck operations. Continuing SBA Structures and Materials NNR research for advanced airframes in metallic structures, combined loading mechanics, lightweight advanced polymer and ceramic composites, inspection and repair of composite structures, material coatings and sealants, and advanced concepts in manufacturing and multifunctional structures. Science of Autonomy Conduct basic research related to critical multidisciplinary autonomy challenges that cut across areas/domains, including air, sea, undersea and ground. This includes multi-disciplinary research into the science of autonomy focuses on four interrelated areas: scalable and robust distributed collaboration among autonomous systems;					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
human/unmanned system collaboration; autonomous perception and intelligent decision-making; and intelligent architectures for autonomous systems. Advanced Naval Power Systems Conduct basic research related to critical S&T to investigate efforts related to thermal science and engineering; power electronics/electro-magnetics; and energy conversion, storage and generation. Pursue research in computer-aided material design; scarce materials mitigation strategies; electrochemical materials; and functional polymeric materials. Advanced Sea Platform Performance Conduct basic research related to critical S&T to investigate efforts related to propulsor, surface ship, and subsurface hydrodynamics; platform mobility; alternative hull materials; and structural acoustics. Expand research related to naval engineering and platform design, including Ohio Replacement Program efforts, and centers for innovative naval technology. Sea Platform Survivability Science Conduct basic research related to critical S&T to investigate efforts related to platform structural reliability; advanced control; acoustic and non-acoustic (electromagnetic) signatures; computational mechanics; metamaterials; and multihull design and optimization. Materials, Coatings and Corrosion Control Science Conduct basic research related to critical S&T to investigate corrosion control technologies. Pursue research in identifying new materials and coatings for naval applications. Ship and Air Platform Machinery and Systems Conduct basic research to advance the technical superiority of Sea-Based Aviation Science and Technology NNR in propulsion, power and thermal management related technologies with emphasis on propulsion cycles, subsystems, and integration, turbomachinery and drive systems, jet noise reduction, hot section materials and coatings, and small UAV propulsion. Conduct research to improve the power density, fuel efficiency, range and					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
operating reliability of future large, medium and small engines. Continue studies to obtain a better fundamental understanding of the technologies involved with Rotating Detonation Engines and integration into platforms and weapon systems using thermodynamic models, Computational Fluid Dynamics and sub-scale experiments. Pursue research for better fundamental understanding of the underlying physics of jet noise production from multi-stream, hot, supersonic jets, and control schemes through fundamental modeling of unsteady and turbulent flow fields and development of more accurate and efficient computational tools. Continue basic research to improve jet engine material durability and temperature and temperature rate capabilities in both benign and corrosive environments. Increase the technical maturity of lightweight ceramic heat exchangers for small engines. ***FY 2018 OCO Plans:*** N/A					
Title: ATMOSPHERE AND SPACE SCIENCES	24.867	24.352	25.547	0.000	25.547
Description: Efforts include: Marine Meteorology and Prediction, and Space Sciences. This program supports innovative basic research on physical process studies, fundamental observations, new sources of data, and modeling in the atmosphere and space with the goal of improving predictive capabilities in the major research area of Operational Environments. Emphasis is placed on the marine atmosphere, the tropics, polar regions, the ionosphere and other areas where new understanding is needed in order to overcome predictability barriers that limit the accuracy of current forecast models. Efforts are underway to understand the interactions of physics between the atmosphere, space, land, ocean and ice, represent these coupled processes in models, and extend them across scales from local to planetary, with the goal extending the skill of predictions to longer timescales (i.e. seasonal to interannual). Recent efforts have also focused on the processes that control tropical cyclone formation, structure and intensity changes and processes that affect electromagnetic and electro-optic propagation in the marine atmosphere. Accomplishments and plans described below are examples for each effort category. Funding increase in 2018 is the result of several increased Department Research Initiatives in the areas of Extramural Marine Meteorology and Prediction, Intramural Battlespace Environments, Extramural Space Sciences, and Intramural Space Research. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Marine Meteorology and Prediction					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued the development of next-generation ocean-atmosphere coupled models. - Continued effort to investigate and better understand the bulk exchanges, aerosol-cloud interaction, and physical processes that take place at the atmospheric boundary layer interface. - Continued theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. - Continued effort to gain a fundamental understanding of the flow-dependent limits of predictability by combining research in data assimilation and atmospheric instability. - Continued investigation into the near-earth environmental effects on electromagnetic propagation. - Continued investigation of sub-grid-scale processes that influence marine boundary layer turbulence, aerosol production and removal, and marine stratocumulus cloud and drizzle formation and dissipation with the goal of improving the predictability of these phenomena in high-resolution mesoscale prediction systems. - Continued investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves. - Continued effort to assimilate WindSat wind vector, Ozone Mapping and Profiler Suite (OMPS) ozone profiles, and Global Positioning System (GPS) temperature and water vapor profile retrievals into NOGAPS (Navy Operational Prediction System). - Continued assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models. - Continued development of new soil moisture retrieval algorithm that addresses the basic modeling issues pertinent to soil moisture retrieval using passive microwave data from the WindSat instrument. - Continued demonstration and validated a new data assimilation capability in NOGAPS ALPHA to generate the first global atmospheric analysis fields that extend from the ground to the edge of space. - Continued effort to derive and test advanced nonlinear atmospheric data assimilation algorithms using variational and ensemble techniques that are firmly based on modern inverse problem theory. - Continued effort to understand the fundamental physics and dynamics that control cloud and aerosol variability in the marine boundary layer. - Continued effort to improve understanding of sub-seasonal, seasonal and intra-seasonal oscillation in a fully coupled (air, sea, land, ice) Model with the goal of developing a seamless, high-resolution earth system prediction capability for extended range forecasts. - Continued the effort to understand the impact of skewness on our ability to estimate meteorological variables and their uncertainty. - Continued the effort to understand the predictability of weather in future extreme environments by quantifying how these changes impact forecast error growth and energy, non-local errors and tropical cyclone prediction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued the study to understand the interplay of deep convective and boundary layer processes in tropical cyclone eye/eyewall dynamics and symmetric/asymmetric inner-core variability through a combination of numerical models, observation and improving upon existing theory. - Continued investigation of tropical cyclone intensification and structure changes that occur in response to changes in upper level outflow, large scale environmental interactions and/or internal changes in convection using innovative new observing systems and satellite observations. - Continued the effort to understand and diagnose the aspects of a multi-model ensemble prediction system that make it ostensibly superior to a single model ensemble prediction system, with the aim of extending the Navy's ensemble predictive capabilities and providing the Navy with an ensemble prediction system that performs competitively with multi-model ensembles. Space Sciences - Continued program to advance state-of-the-art specification and prediction of the space environment to improve space system performance and their on-call availability. - Continued monitoring of other-agency efforts for 'Naval Harvest' of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography. - Continued a focused program to develop a predictive, operational capability for the onset and evolution of equatorial spread-F that limits space-based communications and navigation capabilities. - Continued program to extend magneto-hydrodynamic models of solar activity, and related effects on the near-Earth space environment, toward an improved predictive capability on communication and navigation systems, and other related effects on DoD operations. - Continued effort to develop a better physical understanding of small-scale atmospheric wave dynamics in the middle and upper atmosphere. - Continued effort to develop understanding to forecast the sun's changing extreme ultraviolet (EUV) radiation and the responses of the upper atmosphere and ionosphere one-to-ten days in advance. - Continued investigation of the driving mechanisms, mode characteristics, and impact on space plasmas of electromagnetic waves relevant to radiation belt remediation and auroral ionospheric space weather. - Continued effort to assemble individual databases and model components of the Sun-Earth System. - Continued effort to quantify the evolution of probability density functions for orbiting objects in a crowded space environment, which will help inform orbital debris mitigation and avoidance strategies. - Continued investigation into the coupling physics, dynamics, and chemistry from the lower atmosphere, earth surface, and ocean into the upper atmosphere and ionosphere, focusing on processes relevant to ionospheric specification and forecasting.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued efforts to estimate the probable state of the extended operational environment, from surface to space, in future years-to-decades as a result of natural and anthropogenic influences. - Continued efforts to use acoustic wave analysis techniques to produce three-dimensional maps of emerging solar flux below the sun's surface, towards giving longer warning times for geoeffective space weather that is driven by solar disturbances. ***FY 2017 Plans:*** Marine Meteorology and Prediction - Continue all efforts of FY 2016, less those noted as completed above. - Complete investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves. - Complete assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models. Space Sciences - Continue all efforts of FY 2016, less those noted as completed above. ***FY 2018 Base Plans:*** Extramural Marine Meteorology and Prediction Complete a research initiative to improve the sub-grid scale parameterization of clouds, radiation and mixing in the marine boundary layer that developed several innovative new "scale-aware" parameterizations; transition these to applied research and, in one case, directly into a new version of the Navy's global numerical weather prediction system (NAVGEM), which resulted in a major improvement of several objective measures of predictive skill related to clouds and precipitation over the oceans. Conduct high-altitude airborne field experiments over major hurricanes during which an unprecedented set of high-resolution soundings covering the full depth of the storms will be obtained that allow detailed physical processes to be observed for the first time. These results will be analyzed, applied to existing models and have demonstrated the potential to make a substantial improvement in the ability to predict intensity and structure change in tropical cyclones. Intramural Battlespace Environments Conduct basic research into the understanding of atmospheric processes ranging from thousands of kilometers down to meters, including interactions of the atmosphere with the land, sea, wave, and ice. Continue research to improve our ability to exploit environmental observations to help us characterize those processes more					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
accurately. Conduct research in the littoral zone, where complex topography and air-sea-land contrasts affect the environment on very short time and space scales, as well as in the tropics and sub-tropics, where longer time scale oscillations and seasonal signals also affect short-term weather events. Develop a better fundamental understanding, measurements and predictive models to mitigate shortfalls. Continue investigation of the interface between the troposphere and stratosphere is gaining increased attention because of its possible effect upon medium term weather prediction. Extramural Space Sciences Continue investigation of methods to assimilate these observations into space weather models, with an eventual goal of a prediction system that could provide detection and warnings of tsunamis as a variety of observational systems will be utilized to increase the understanding of the physics of ionospheric irregularities and other space weather phenomena. Recent observations have shown that a number of phenomena, including tsunamis, can generate acoustic gravity waves that have an airglow signature in the thermosphere/ionosphere. Intramural Space Research Conduct basic research integrated across three environmental areas -- geospace, heliospace, and high-energy space -- which underpin, connect, and inform successful operations, with metrics to increase technology readiness and to foster transition. Initiate geospace efforts to investigate the physical mechanisms responsible for the formation of sporadic ionospheric mesoscale structures that impact ionospheric radiowave propagation, to improve high-frequency (HF) systems performance for operational planning purposes. Initiate heliospace efforts to develop the science base necessary to forecast geo-effective solar energetic particle (SEP) events that are hazardous to spacecraft operations and human activities in space. Initiate high-energy space efforts to advance understanding about millisecond pulsars and the physics that underpins their use as space-based clocks for navigation and timing. ***FY 2018 OCO Plans:*** N/A					
Title: SCIENCE ADDRESSING HYBRID THREATS	16.533	17.032	23.696	0.000	23.696
Description: The Sciences Addressing Hybrid Threats (formerly Counter Improvised Explosive Device (IED) Sciences program provides research for Naval Forces to fight hybrid threats, and adversaries in expeditionary operations. Naval Expeditionary Forces need science advances to address a range of Basic Research					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
challenges that result from physical and operational environmental limitations so harsh that solutions push basic discovery and invention. Naval Forces able to operate amphibiously and in the littoral will have all of their capabilities exposed to degrading sea and land physical effects. Expeditionary forces operating austerely must be agile and lethal but will be constrained by size, weight, and power requirements and must be sustained across distributed forces covering large areas. Further complicating the problem context is the nature of hybrid threats, and adversaries. A hybrid adversary can be state or non-state using a combination of conventional and irregular methods and weapons. For example a hybrid threat could use criminal acts in concert with conventional artillery and IEDs and in turn social media for combined effects greater and broader than the sum of the parts. These coordinated multivariate threats occur across the spectrum of conflict with a dynamic but unified strategy. A hybrid adversary is flexible and adapts quickly, synchronizing advanced state weapons systems, disruptive commercial technologies, cheap expedient homemade weapons, and a variety of tactics. The Sciences Addressing Hybrid Threats program seeks to establish and nurture science to address these threats not covered in more conventional warfare science efforts and in environments not researched elsewhere. Within the above threat and environmental context numerous warfighting capability dependencies are considered resulting in a broad range of science research areas. Examples include: physics addressing the electromagnetic spectrum for use in Command and Control and high energy physics addressing Directed Energy Weapons; machine perception, reasoning and collaborative behaviors of autonomy enabling numerous potential expeditionary autonomous systems; artificial intelligence enabling future Intelligence systems; optics, electronics, and photonics research to enable revolutionary spectral awareness in small low power sensors; computer and network science to enable expeditionary computing coupled with Data Science research to conduct data analysis; fundamental chemistry and materials science research to advance technologies to support sustainment; basic materials research to explore and improve armor and structural materials; electrochemical energy conversion and storage research to sustain the force; chemistry and physics to provide disruptive energetics for expeditionary Fires; and biology, physiology, and cognitive sciences addressing the Naval Expeditionary warfighters human abilities. The program also seeks to establish and nurture a multidisciplinary Science and Technology community of Government, academic and industry researchers to accelerate the transition of new science and technology into fielded systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Funding increase in 2018 is the result of DON increased basic research to include a complex, hybrid adversary consisting of state and non-state actors in order to better reflect the threat environment that Naval Forces will face in the future. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** - Continued effort in the area of Prediction to develop theoretical and technical approaches that permit prediction and analysis of IED emplacement as well as the assembly of IEDs. This included recognition of emplacement patterns, human activity recognition from video and other sensing systems, human intelligence and social network analysis of terrorist networks, modeling and simulation of the full spectrum of IED activities, analysis of communications, and knowledge management systems to combine diverse data sources. - Continued effort in the area of Detection to develop concepts that would permit stand-off detection and localization of the explosive, the case materials, the environment in which the device is located, and other components of the IED. - Continued effort in the area of Neutralization to develop scientific concepts that may be applied to remotely render an IED ineffective without necessarily having to detect or destroy it. - Continued effort in the area of Destruction to develop scientific concepts that may be applied to quickly and remotely destroy IEDs without necessarily having to detect them. - Continued creation of new spectroscopy for sensitive characterization of semiconductor nanostructures, ultrathin molecular films and chemical/biological threat materials and explosives. - Continued development of a new chemical explosive detection concept based on pump/probe ultra-short pulse lasers. - Continued research on characterizing background noise in urban and riverine environments in support of IED signature detection. - Continued effort to directly observe lattice deformations in explosives under shock impact. - Continued investigations into sociological and cultural aspects of defeating insurgent networks. - Continued investigations into standoff wide area neutralization and pre-detonation of IEDs. - Continued investigations into stronger lightweight armor including nanoparticle designs. - Continued investigations into detection of physical and temporal device characteristics. - Continued investigations into challenges within the Riverine environment. - Continued investigations into challenges in the temporal domain in various land environments. - Continued an effort to integrate observable behaviors with social behavior models to provide inputs for predictions and validation.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued a program to investigate nano-technologies applied to miniaturized remote molecular sensors, with an additional emphasis on low fidelity detection of trace explosive vapor partial-pressures. - Continued research into emerging very-broad-band spectroscopic capabilities to achieve a low-fidelity mosaic of partial pressure detections of explosives. - Continued study of energy transduction through soft armor. - Continued a Neutralize effort to investigate the identification of techniques to deflagrate or detonate explosives by creating hot spots or other localized effects that do not quench. - Continued a Neutralize effort to investigate new energy conversion schemes and extraction mechanisms for high-powered microwave sources that have potential to dramatically reduce the size, weight, and power required. - Continued a Neutralize effort to research compact wideband metamaterial multifunctional antennas. - Continued a Mitigate effort to explore new chemistry techniques to optimize polymer fiber growth and hardening. - Continued a Mitigate effort to develop in-situ analytical tools to observe nano to micro structure of materials during fabrication and treatment processes. - Continued study of Evaluation of the Dynamic Behavior and Material Parameters of the Human Brain. - Continued study of Real-Time Control of NMR Relaxation for Improved Sensitivity and Resolution. - Continued research on lightweight flexible materials that can selectively absorb, dissipate, and convert high energy electromagnetic waves or blast waves. - Continued research on compact and efficient high voltage pulsed switches that can rapidly charge and discharge at a high repetition rate. - Continued an effort to detect a wider variety of homemade explosives. - Completed Neutralize effort to investigate new energy conversion schemes and extraction mechanisms for high-powered microwave sources that have potential to dramatically reduce the size, weight, and power required. - Completed a Neutralize effort to research compact wideband metamaterial multifunctional antennas - Initiated research into the improved biomechanics and physiology of detection dogs for use in the detection of explosive hazards. - Initiated research efforts to produce the knowledge and understanding necessary to detect and locate asymmetric explosive threats and their components by exploring combination of their unique passive and active characteristic responses at safe stand-off distances from various expeditionary platforms. - Initiated research efforts to explore new lightweight multifunctional material design and techniques to optimize existing materials to improve protection from detonation effects.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated research efforts to neutralize or prevent explosive threats with or without direct knowledge of their locations. - Initiated research efforts to provide understanding of the human and social elements and their relationships with asymmetric explosive threats to predict and prevent explosive events. ***FY 2017 Plans:*** - Continue all effort of FY 2016, less those noted as completed above. - Complete efforts in the area of Destruction to develop scientific concepts that may be applied to quickly and remotely destroy IEDs without necessarily having to detect them. - Complete creation of new spectroscopy for sensitive characterization of semiconductor nanostructures, ultrathin molecular films and chemical/biological threat materials and explosives - Complete effort to directly observe lattice deformations in explosives under shock impact - Complete investigations into challenges within Riverine Environment. - Initiate research efforts to improve stimulated electromagnetic explosive signature collection efficiencies. - Initiate research efforts to explore compact rapid high selectivity spectroscopic detection in distributed unmanned platforms. ***FY 2018 Base Plans:*** Sciences Addressing Complex Hybrid Warfare Threats (Formally Known as Counter-Improvised Explosive Device (IED) Sciences) Extramural SAHT Initiate Sciences Addressing Complex Hybrid Warfare Threats efforts. S&T efforts will address multi-faceted threats that employ both conventional and unconventional forces. This activity was originally formed to address Counter-Improvised Explosive Device (IED) Sciences, which are a component of Complex Hybrid Warfare Threats. However, there are additional emerging components of complex hybrid threats that must be addressed with these efforts as well as the challenges imposed by Naval Expeditionary Operations and as such the PE will address a broad range of hybrid threats not only IEDs and the science challenges associated with these environments. This activity will also incorporate Expeditionary Operations activities to facilitate the consolidation described above. Continue all Expeditionary Operations efforts of FY 2017. Complete basic materials research to explore and improve high strain and stress rate performance of high performance fibers, armor inserts, and structural materials. Complete fundamental chemistry and materials science research to advance water purification					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
technologies. Complete basic research to advance electrochemical energy conversion and storage. Initiate Investigations into novel hybrid devices, making use of the optical, electrical, and acoustic regimes. These devices will enable photonic and electronic domain access and manipulation of the electromagnetic spectrum across multiple octaves of bandwidth. Such devices will enable previously-unattainable real-time spectral awareness and performance. Initiate basic research to advance machine perception, reasoning and collaborative behaviors of autonomous systems during Amphibious Operations. Extramural C-IED Science Continue efforts of FY 2017. Complete investigations into challenges in the temporal domain in various land environments. Complete the program to investigate nano-technologies applied to miniaturized remote molecular sensors, with an additional emphasis on low fidelity detection of trace explosive vapor partial-pressures. Complete research on compact and efficient high voltage pulsed switches that can rapidly charge and discharge at a high repetition rate. Complete C-IED mitigation and destruction activities. Intramural Information Technology Research to support the identification of previously unsuspected people caught on camera engaging in hostile acts by developing a robust approach for identifying people given only one or a small number of photos by comparing these photos to images on the Internet and in existing databases. Intramural Materials and Chemistry Evaluate and quantify the changes in electrical signaling, resulting from strain on the neuronal cells subjected to shock and blast waves. The study is critical to define and understand blast and impact injuries at the cellular level resulting in mild or severe traumatic brain injury. Study hearing loss from repeated exposure to high levels of acoustic waves created by high performance jet engines operating on ocean platforms. Develop an understanding of fundamental changes on IR optical standoff and point detection of improvised explosives, chemical warfare agents and toxic industrial chemicals. Develop and demonstrate a predictive framework of IR spectral signatures based on the fundamental optical properties of materials. Intramural Electronics					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Create new knowledge and understanding and explore new concepts, techniques and methods, for the design, growth, and characterization of electronic and electro-optic sensors to counter IED's. ***FY 2018 OCO Plans:*** N/A					
Title: HUMAN SYSTEMS ***Description:*** Efforts include: human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** - Continued research of social networks for counterterrorism. - Continued expansion of the cognitive architectural modeling capability to increase coverage, including spatial reasoning, multitasking, and impact of physiological and stress variables. - Continued research of human cognition and performance to create more realistic simulations for training. - Continued program to combine cognitive architectures with computational neuroscience to better predict human performance. - Continued program on implantable electronics for performance enhancement. - Continued investment in natural language interaction capability for artificially intelligent training systems. - Continued research of neuro-control of high-lift bio-inspired Unmanned Underwater Vehicles and active vision and cognitive navigation skills in mobile robots. - Continued computational neuroscience for novel pattern recognition and sensory augmentation. - Continued research of human-robot interaction to support team collaboration. - Continued the output human performance usability models with actual human performance results obtained in usability testing on systems under development. These systems include future Naval Combat Systems and Homeland Security Operation Centers. - Continued investigation of human sensory performance for optimizing video and audio human-electronic device interfaces. - Continued research to create new social modeling tools for understanding the responses of adversaries, determining the best practices for containing and deterring the adversary, and developing effective course of action in non-Western environments for humanitarian and civilian-military operations.	17.117	16.078	15.500	0.000	15.500

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research of advanced biometrics such as biodynamic signatures to support spirals 2 and 3 of the Navy Identity Dominance System - Maritime Domain. - Continued efforts to extend the representational capabilities of cognitive architectures to accommodate aspects of social cognition and teamwork. - Continued efforts to develop an empirical understanding and prediction of the behaviors of individuals and social groups and networks, computational approaches to social network theory and the co-evolution of adversarial tactics and strategies, algorithms for exploring scenarios that take into account socio-cultural factors; political and economic factors; local attitudes, values, and social structure. - Continued research of human activity and intend recognition and dynamic biometrics for improved human system interfaces and force protection. - Continued research into probabilistic reasoning in computation cognitive architectures. - Continued research into computational social neuroscience to provide new models for manpower assignment and incentivization and new social models of cross-cultural interactions. - Continued research on models of social dynamics and culture in small scale societies. - Continued research to explore the development of algorithms to automate assessment of the information value of Command and Control (C2) related data for next generation C2 systems. - Continued research to explore to dynamically provide decision support in support of rapid mission planning, re-planning and execution at command and combatant echelons. Research thrust to include dynamic mapping of decision space and decision-based, dynamic task allocation algorithms. - Continued research to explore concepts of operations for the management of information in hybrid autonomous systems. - Continued research on social neuroscience of Trust. - Continued research on data collection and processing for health surveillance and medical assistance. - Continued research on brain-inspired intelligent systems to enable high-level interaction between warfighters and autonomous systems. - Continued research on geography, health and disaster for next generation information systems for collaborative humanitarian assistance. - Continued socio-culture research of complex humanitarian operations. - Continued development of intelligent, embedded assessment for Intelligent Tutoring System (ITS). - Continued research on socially guided machine learning. This includes robotic teammates learning from human teachers both by demonstration and verbal instruction. - Continued the early exploration of modeling the cognitive basis for human moral judgments. - Continued research to explore concepts of operations for the management of information in hybrid autonomous systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research to improve collaborative systems and trust in computer mediated environments. - Continued research into cost effectively adapting current intelligent tutoring technologies to wider dissemination across Navy schoolhouses. - Continued research to address visualization and synthesis from multiple data sources to support autonomous systems and small hybrid teams. - Continued research on portable, intelligent, computer based expert decision aids for maintenance applications. - Continued research on computational models for predicting human error on procedural tasks. - Continued research on cognitive modeling for cyber security. - Continued research seeking a unified theory of the overall decision process, including the role of judgment with the goal that the unified theory will link currently existing, but isolated, conceptual theories of decision making, judgment, sensing, and detection. - Continued research into strategies for and utility of incorporating uncertainty into planning and asset allocation in Naval missions. - Continued research on human performance sources of cyber vulnerabilities of unmanned vehicle (UxV) systems. - Continued human systems integration research to reduce workload and increase operator situational awareness in command information center. - Continued research to understand and dynamically model context in operational decision making. - Continued research on statistical language translation for content analysis of threat behaviors and human security issues. - Initiated research on training and neuro-cognitive plasticity.					
FY 2017 Plans: Human Computer Interaction/Visualization - Continue all efforts of FY 2016, less those noted as completed above. Command Decision Making (CDM) - Continue all efforts of FY 2016, less those noted as completed above. Social Network Analysis - Continue all efforts of FY 2016, less those noted as completed above. - Initiate research on social cyber-behavior, information operations and hybrid warfare. - Initiate research on data visualization, data fusion and novel information streams for understanding novel warfighting problems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Hybrid Human Computer Systems - Continue all efforts of FY 2016, less those noted as completed above. Enhancing Warfighter Cognitive Capability - Continue all efforts of FY 2016, less those noted as completed above. Cognitive Science of Learning - Initiate research on maintenance skill acquisition and retention. ***FY 2018 Base Plans:*** Human Computer Interaction/Visualization Conduct basic research in the computer centric environment of today's Navy and Marine Corps. Study human systems integration to reduce workload and increase operator situational awareness in a command information center environment. Investigate human sensory performance for optimizing video and audio human-electronic device interfaces and computational neuroscience for novel pattern recognition and sensory augmentation. Continue research on socially guided machine learning to include robotic teammates learning from human teachers by demonstration and verbal instruction. Conduct research of human-robot interaction to support team collaboration and research to address visualization and synthesis from multiple data sources to support autonomous systems and small hybrid teams. Continue research on brain-inspired intelligent systems to enable high-level interaction between warfighters and autonomous systems. Command Decision Making (CDM) Conduct basic research to explore the development of algorithms to automate assessment of the information value of Command and Control (C2) related data for next generation C2 systems. Research strategies to incorporate uncertainty into mission planning and asset allocation in naval missions and to understand and dynamically model context in operational decision making. Explore decision support as it applies to rapid mission planning, re-planning and execution at command and combatant echelons. Research thrust to include dynamic mapping of decision space and decision-based, dynamic task allocation algorithms. Continue research on geography, health and disaster for next generation information systems for collaborative humanitarian assistance. Seek a unified theory of the overall decision process, including the role of judgment with the goal					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
that the unified theory will link currently existing, but isolated, conceptual theories of decision making, judgment, sensing, and detection. Social Network Analysis Conduct basic research of social networks for counterterrorism including research to create social modeling tools for understanding the responses of adversaries, determining the best practices for containing and deterring the adversary, and developing effective course of action in non-Western environments for humanitarian and civilian-military operations. Develop an empirical understanding and prediction of the behaviors of individuals and social groups and networks, computational approaches to social network theory and the co-evolution of adversarial tactics and strategies; algorithms for exploring scenarios that take into account socio-cultural factors; political and economic factors; and local attitudes, values, and social structure. Execute research efforts to extend the representational capabilities of cognitive architectures to accommodate aspects of social cognition and teamwork. Investigate social cyber-behavior, information operations and hybrid warfare. Study data visualization, data fusion and novel information streams to understand warfighting problems. Initiate research on competitive narrative and digital media assessment. Hybrid Human Computer Systems Conduct basic research into creating systems in which the functions of a human operator (or a group of operators) and a machine are integrated. Perform research to explore concepts of operations for the management of information in hybrid autonomous systems. Execute research to improve collaborative systems and trust in computer mediated environments. Investigate statistical language translation for content analysis of threat behaviors and human security issues. Conduct research of neuro-control of high-lift bio-inspired Unmanned Underwater Vehicles and active vision and cognitive navigation skills in mobile robots. Continue program on implantable electronics for performance enhancement. Enhancing Warfighter Cognitive Capability Conduct basic research into probabilistic reasoning in computation cognitive architectures and the expansion of the cognitive architectural modeling capability to increase coverage, including spatial reasoning, multitasking, and impact of physiological and stress variables. Extend research into a program to combine cognitive architectures with computational neuroscience to better predict human performance. Research the output human performance usability models with actual human performance results obtained in usability testing on					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
systems under development. These systems include future Naval Combat Systems and Homeland Security Operation Centers. Continue research of human activity and intend recognition and dynamic biometrics for improved human system interfaces and force protection. Conduct research of human cognition and performance to create more realistic simulations for training, including research into cost effectively adapting current intelligent tutoring technologies to wider dissemination across Navy schoolhouses. Extend training scientific study into the development of intelligent, embedded assessment for Intelligent Tutoring System (ITS). Research cognitive modeling for cybersecurity and research on human performance sources of cyber vulnerabilities of unmanned vehicle (UxV) systems. Develop computational models for predicting human error on procedural tasks. Investigate training efforts on neuro-cognitive plasticity. ***FY 2018 OCO Plans:*** N/A					
Title: MATHEMATICS, COMPUTER, & INFORMATION SCIENCES	43.650	42.190	45.391	0.000	45.391
Description: Efforts include: Mathematical foundation and computational theory and tools for design, communication, and control of intelligent autonomous systems; theory, algorithms and tools for decision support; decision theory, algorithms, and tools; heterogeneous information integration, management, and presentation; information assurance, computation and information foundation for cyber defense, secure and reliable information infrastructure for command and control; mathematical optimization for optimal resource allocation and usage; modeling and computation of complex physical phenomena; modeling and computation for electromagnetic and acoustic wave propagation and scattering; seamless, robust connectivity and networking; foundations for novel computing hardware, including nanoscale materials, emerging devices and circuits, emerging computational architecture and nanofabrication. Funding increase in 2018 is the result of increased research initiatives in the area of Extramural Machine Learning, Reasoning and Intelligence. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** - Continued development of mathematical optimization framework and heuristic algorithms that serve as theoretical and computational basis for network design, resource allocation, and logistics. - Continued development of improved tactical and battlespace decision aids. - Continued to refine techniques for extracting maximum knowledge from multi-modal imagery, text, and multisource signal data.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued to investigate methods to deal with light dispersion on image formation underwater to enable precise navigation, station keeping, and mapping capabilities for unmanned underwater vehicles. - Continued efforts for enabling teams of autonomous systems to work together and work on representations for evolution of cooperative behaviors, including efforts in multi-modal interactions with autonomous systems. - Continued developing framework for dealing with effect of variable latencies in communication within teams of humans and autonomous systems. - Continued efforts on quantum computing and cryptography. - Continued efforts on model checking and automated theorem prover technologies. - Continued efforts in mathematical modeling of complex physical phenomena. - Continued efforts in mathematical techniques for inverse problems, including reliable approximate solutions in 3-dimensions (3D); adequate representation of the physics of the media and the scatterer; and improved resolution of structural and material properties. - Continued focused efforts in development of mathematical foundations for image understanding on a number of key challenges, such as multimodal imagery representation and metrics, object recognition, scene analysis and understanding. - Continued development of mathematical, statistical, and computational framework leading to robust underlying approaches for automated information integration of disparate sources of data. - Continued research in cognitive radio and networking protocols. - Continued research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas. - Continued research in cross-layer wireless protocols for delay sensitive network traffic. - Continued multidisciplinary research efforts to focus on intelligent control systems, cooperative behavior modeling and response, UxV-human interactions and adaptive mission methodologies. - Continued development of an interaction model of how users characterize visual content and context to improve video surveillance. - Continued development of improved formal foundations, methods, and tools for compositional verification and construction of high assurance software systems. - Continued investigation of relational constructive induction, semi-supervised learning, and classifier ensembles to improve collective classification technology and operations based automated decision aids. - Continued research aiming to develop principled, trustworthy, yet practical and usable approaches to address the issue of software producibility and the development of complex software systems with ensured interoperability. - Continued research into anti-tamper and information assurance: research focused on protection techniques, architectures, algorithms, protocols that allow for security and cyber situational awareness.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research to develop mathematical and computational tools for compressive sensing. - Continued the development of theory and algorithms for quantum communications. - Continued efforts addressing the representation, computation, and analysis of information from large diverse data sets. - Continued research efforts to develop tools for proactive information assurance and cyber space security. - Continued multidisciplinary research efforts on reasoning for image understanding in uncertain environments. - Continued multidisciplinary research efforts to provide information assurance foundations for countering the Botnet threats. - Continued research efforts addressing computational complexity arising from network-enabled computing, such as cyber security, information integration, and intelligent autonomy of networked, cooperative systems. - Continued mathematical studies to understand the micro-physics of a liquid-solid-gas interaction in turbulent flow conditions. - Continued research efforts for mathematical development of physics-based computational and signal processing techniques for understanding and characterizing biological-acoustical coupling in acoustic wave propagation and scattering. - Continued effort to optimize quantum communication bandwidth in noisy environments by developing a new mathematical representation of quantum information. - Continued research on mathematical and computational building blocks for machine reasoning and intelligence. - Continued multidisciplinary research efforts on knowledge representation and reasoning for decentralized autonomy. - Continued research efforts on algorithmic solutions and explicit measurement schemes for networks inference and monitoring. - Continued research on novel techniques for interference mitigation. - Continued efforts to develop computer sciences foundation for quantum information sciences leading to new ways of computing and communication. - Continued research to develop a theory of trust-based traffic security by creating models of trust, network structure and dynamics, and incentives and economics. - Continued research to develop the foundation for new techniques that enable the adaptive characterization of evolving computer network traffic patterns. - Continued research on distributed network synchronization. - Continued efforts to extend theory of quantum communication channels beyond completely positive channels. - Continued efforts to leverage node cooperation to counteract interference in tactical networks.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research into improving the perceptual abilities of autonomous systems by developing a unified theory of perception and context that includes spatial and co-occurrence context to enable autonomous systems to effectively reason about context as part of the perceptual process. - Continue studies of analog intelligent nanoelectronics computational architecture (transfer from SEEW). - Continued research on optical and plasmonic properties of graphene in infrared (IR) and terahertz (THz) spectral regions (transfer from SEEW). - Continued research on 2D materials other than grapheme (transfer from SEEW). - Continued research on chemical synthesis of carbon nanostructures (transfer from SEEW). - Continued research towards detecting and manipulating Majorana fermions in condensed matter systems (transfer from SEEW). - Continued studies of topological insulator materials and novel device concepts exploiting properties of transport in their protected electronic state (transfer from SEEW). - Continued research on spin dynamics in Group IV semiconductors and related device concepts (transfer from SEEW). - Continued research efforts on non-conventional nanofabrication that hold promise for sub-10nm resolution (transfer from SEEW). - Continued research on defect engineering and characterization in grapheme (transfer from SEEW). - Completed research on duel-STM characterization of graphene film (transfer from SEEW). - Completed studies of chemical vapor deposition (CVD) of graphene on copper (transfer from SEEW). - Completed research on spin properties in topological insulators (transfer from SEEW). - Initiated tip-based atomic-scale nanofabrication program (transfer from SEEW).					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete research on novel techniques for interference mitigation. - Complete research in cross-layer wireless protocols for delay sensitive network traffic. - Complete research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas. - Initiate research on dynamic military communications under spectral, spatial and temporal uncertainty. - Initiate research on broadband channel receiver architectures with interference suppression. - Initiate research on capacity limits and optimal transmission strategies for heterogeneous networks. - Initiate research on prioritization, latency, and end-to-end service level guarantees in heterogeneous networks.					
FY 2018 Base Plans: Extramural Communications and Networking					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue basic research in antenna technology to include electrically small antennas, wideband multifunction antennas, compatibility of phased array antennas with naval platforms and marine environments, directional beam forming/steering techniques, and special-purpose submarine communication antenna systems; radio communications to include anti-jam and low-probability-of-intercept techniques, SATCOM performance enhancements, interference mitigation, adaptive equalization, bandwidth efficient modulation, cognitive radio for dynamic spectrum management, and high data rate tactical communications techniques including communications at speed and depth (for submarines); and wireless networks to include mobile ad-hoc wireless networking algorithms/protocols, end-to-end Quality-of-Service, joint/coalition interoperability, service oriented tactical networking, mission-based policy and network controls and management.					
Extramural Quantum Information Sciences					
Continue basic research of quantum key distribution (QKD) protocols and implementations for the purpose of understanding the security implications for QKD in the maritime environment, the development of protocols that simultaneously minimize leakage of information to the environment and the creation of secure networks, as well as schemes to maximize the information carried by a continuous or discrete variable; and research of algorithms for naval functions such as routing, weapon-target pairing, etc., a key application such as radar cross section calculation.					
Extramural Nanoscale Computing Devices and Systems					
Discover and develop novel techniques for synthesis, assembly and characterization of molecular scale (sub-10nm) nanographene structures for their electronic, optical, magnetic and quantum functionalities. Research, assess, test and develop alternative computing architectures (beyond von-Neumann), including but not limited to, various implementations of neuromorphic architectures and quantum information systems.					
Extramural Mathematical Data Science					
Continue basic research in mathematics, probability, statistics, signal processing, machine learning, data engineering, and information theory. The program aims to develop rigorous mathematical and algorithmic answers to questions that are currently addressed using heuristics or non-principled approaches. Focus is on problems in learning and inference from both big and small data, representation of data, modeling					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
dynamical properties of and determining causal effects in complex networks, multi-modal, multi-scale information integration, and decision making under uncertainty. Extramural Machine Learning, Reasoning and Intelligence Continue basic research in the area of building intelligent agents that can function in the environments in which warfighters operate, that is, environments that are unstructured, open, complex and dynamically changing. Agents (cyber or physical) do not yet have the level of intelligence needed to operate in such open, uncertain and unpredictable environments either independently or alongside warfighters. In the area of Intelligence for Autonomous Agents, basic research includes the development of principles for machine intelligence, efficient computational methods, algorithms and tools for building versatile smart agents that can perform missions autonomously with minimal human supervision and collaborate seamlessly with teams of warfighters and other agents. In the area of Image Understanding, basic research includes the development of theory and algorithms for understanding surveillance imagery, for semantic search of visual datasets, and for autonomous agent perception. The main focus is on reconstructing 3D scenes, recognizing object classes and specific objects, recognizing activities and events, inferring intentions, as well as succinct natural language descriptions of images and video. Extramural Applied and Computational Analysis Program Continue basic research in modern and classical mathematical analysis with emphasis on mathematical and computational models of physical phenomena. Naval interest in waves, flows, materials, structures, and information processing motivates research in the areas of multi-phase, multi-physics, including analytically rigorous and computationally robust and efficient modeling of fatigue, fracture, dislocation, nucleation, shocks and contact lines; dynamical systems, and oceanic and atmospheric modeling, including fluid transport, mixing, and predictability of models for nonlinear dynamics; and inverse problems arising from acoustic and electromagnetic wave propagation and scattering. Extramural Cyber Security and Complex Software Systems Continue basic research in computing systems and complex software systems that meet required assurances for security, safety, reliability and performance to measurably improve the information-processing challenges of future naval systems. Cyber Security sub-program investigates and develops wide-ranging principles and techniques for continuously maintaining confidentiality, integrity, and availability of information and information					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
infrastructures, focusing on the software, the hardware and the network. The program seeks to establish an autonomic, secure and dependable informational infrastructure toward achieving Information Dominance. Complex Software sub-program investigates principles, algorithms and methods, and develops software engineering tools for achieving efficient, timely, robust and secure software executables, focusing on science for software construction, correctness and efficiency by revisiting software development and deployment methodology. Efficient, timely, robust and secure software is a requirement for secure information infrastructure toward achieving Information Dominance. Extramural Networked Sensing Continue basic research in optical components and infrared technologies including lasers and focal plane arrays using narrow bandgap semiconductors for the purpose of imaging through clouds, fog, haze and dust; persistent surveillance for severely size constrained airborne applications; detecting anomalies and targets; and autonomous sensing for UAV platforms and networked sensing over multiple sensors and/or sensor platforms. Extramural Mathematical Optimization and Operations Research Continue basic research in mathematical optimization. The primary focus of the program's basic-research portion is linear, nonlinear, integer and combinatorial optimization. Theoretical development, algorithm design and analysis, computational techniques, and software prototypes for solving large-scale problems are of interest. Techniques that produce provably optimal or near-optimal solutions, as well as techniques applicable to large problem domains are favored. This includes, but is not limited to, cutting-plane and polyhedral techniques for mixed-integer programming and interior-point and first- order algorithms for conic/convex optimization. Decentralized optimization is an area of growing interest, as are innovative techniques for dealing with uncertainty, such as stochastic, robust, and online optimization. Intramural Information Technology Conduct basic research to address the continued need for improving the operational capability of Naval information and communication systems in the areas of: high assurance software; secure tactical connectivity; intelligent autonomy; and the processing, integration, and presentation of information. The expected payoff is: the development of improved methods for producing, analyzing, and securing Naval software systems; new design concepts for future Naval tactical communication systems and networks; intelligent autonomy and improved interaction with autonomous systems; and improved methods for analyzing, integrating, and					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
presenting information to users. Given the pervasiveness of software, the techniques developed in this task area should also reduce cost and increase quality of Naval systems and are expected to be applicable to a wide variety of military and civilian problems. Accomplishments include: Developed a machine perception algorithm that detects anomalies with a true positive rate of 91.4% and a false positive rate of 8.71%; Developed and prototyped several new algorithms for proving security properties of computer code; Developed and initiated evaluation of a near-real time system (2-10ms lag) for detecting procedural uncertainty which can indicate when a human subject is about to make an error. ***FY 2018 OCO Plans:*** N/A					
Title: MATERIALS/PROCESSES	55.182	52.942	56.980	0.000	56.980
Description: Efforts include: structural materials; functional materials; maintenance reduction; environmental sciences; undersea warfare, materials and chemistry, and manufacturing science. Accomplishments and plans described below are examples for each effort category. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. Funding increase in 2018 is the result of several increased research initiatives in the area of Extramural Structural Materials. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Structural Materials - Continued development of first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels. - Continued quantification of the corrosion effects on fatigue to be incorporated into the Unified Damage Model (UDM) and validated in a few environmental cases on P-3 aircraft real loads data. - Continued investigating new carbon nanotubes growth methodologies for improved mechanical behavior of advanced composites in next generation ship and aircraft structures. - Continued development of theoretical basis for composite materials behavior based on x-ray computed microtomography. - Continued development of understanding and constitutive models of dynamic behavior of naval steels. - Continued evaluating environmental effects on marine composites and sandwich structures.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued exploration of composition, processing and microstructural evolution in titanium alloys for marine structures. - Continued exploration of multienergy processes for zero maintenance coatings. - Continued investigation of a rapid annealing of surface layers and their effects. - Continued the investigation of processing science (single crystals, coatings, thermal barrier coatings (TBC), heat treatment, etc.) to materials performance for turbine engine components to develop relevant process protocols to optimize and control quality. - Continued to advance the understanding of processing and deformation mechanisms in nanostructured ceramic composites and metal alloys to provide new high strength / high toughness materials for Naval platforms. - Continued to investigate the use of photorefractive crystals for the demodulation of a distributed fiber optic Bragg gratings structural health monitoring system. - Continued research on new hybrid composites that integrate polymers, structural fibers, carbon nanotubes, ceramics and metals, with improved blast, ballistic, fire resistance and mechanical characteristics with special emphasis at the interfacial aspects of the new materials. - Continued efforts to understand and predict salt chemistry effects on high temperature coatings and materials in naval gas turbine environments. - Continued establishing fundamental understanding of the dynamic response and failure of marine composites for development of modeling tools for enhancing dynamic response and projectile resistance for and sandwich structures, and develop modeling tools. - Continued development of new methods for room temperature curing and processing of polymer composites with high temperature thermoxidative stability and fire resistance. - Continued assessment of the blast resistance of cellular structures as functions of soil characteristics. - Continued materials and fabrication science for fugitive phase processes for engineered topological structures for vehicle blast and fragmentation protection. - Continued exploration of fundamental mechanisms and initiate development of physics-based models of electrophoretic deposition of ceramic nanoparticles and subsequent sintering. - Continued physics based models for coupled phenomena in marine composite structures (thermo-mechanical loads, environmental effects, and fluid-structure interactions.) - Continued Computer-Aided Materials Design (CAMD) for discovery, synthesis and testing of various materials. - Continued structure and properties of liquid and glassy metals. - Continued first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels. - Continued scientific basis for the rational engineering design of Al-alloys for Naval applications.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of refractory solid metal carbide composites from metal / polymer precursors. - Continued establishment of mechanics of crack propagation in aluminum structures, and explore concepts for enhancing fracture resistance. Functional Materials - Continued research tools design efforts in electromagnetic and acoustic bandgap materials. - Continued study of new transduction mechanisms. - Continued development of the science and technology base for a highly efficient and stable flexible organic solar cell. - Continued investigation into the properties and fabrication of novel ceramics which have potential to combine hardness, strength, and high transmission in the long wave infrared (LWIR) spectral region. - Continued effort to synthesize beta-SiC power suitable for subsequent densification into transparent beta-SiC ceramic. - Continued meta-materials effort to develop negative index materials with dynamic frequency response. - Continued synthesis and property measurement of new sonar materials predicted by first principle methods. - Continued expansion of first-principles methods devised to calculate piezoelectric properties of materials for sonar transducers to calculate additional materials properties for other applications. - Continued design, processing, and measurements to fashion the new generation of high-strain, high coupling piezoelectric single crystals into high-performance acoustic transducers for naval sonar systems. - Continued basic research into material technology associated with the development of active and conventional armor. - Continued effort to characterize regenerative bacterial nanowires. - Continued effort to synthesize cyclic peptide ring modules and polymerize them into peptide nanotube polymers. - Continued efforts to utilize chemically modified virus proteins as a scaffold to assemble nanostructured metamaterials with unique optical properties including negative index of refraction. - Continued effort to develop surface electrons on diamond. - Continued efforts to develop oxide materials for power management, sensors, and information storage/ processing. - Continued effort to use elastic pentamode metafluid materials for acoustic cloaking. - Continued effort to develop conjugation strategies that can allow the efficient attachment of multiple biological moieties to nanoparticles (NPs) in a controlled manner. - Continued examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used.					

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- Continued effort to characterize the properties of chemically reactive flows subject to non-Kolmogorov or non-equilibrium turbulence, or that creates these types of turbulence. - Continued exploratory synthesis, electromechanical property evaluation and atomic level analysis of new quaternary piezocrystals in order to optimize materials properties for specific Navy SONAR applications. - Continued development of advanced nanostructured magnetic materials for energy applications. - Continued study of Actuatable Peptidyl Motifs for the Nanoscale Control of Materials within Biological Systems. - Continued study of Nanoscale Measurements of Protein Modification in Live Cells. Maintenance Reduction - Continued development of corrosion models. - Continued mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces. - Continued stainless steel carburization study to enhance corrosion performance. - Continued the concept study of multiscale corrosion modeling on naval ship materials. - Continued corrosion prediction using an integrated deterministic-based model. - Continued modeling and simulation of corrosion phenomena. - Continued studies of surface microstructure optimization to enhance corrosion properties of navy marine alloys - Continued sensor development for monitoring microstructural changes on alloys under thermal and mechanical stresses. - Continued research focused on modeling and simulation for platform and system affordability, lifetime materials, shipboard wireless capability, automation to reduce manning. - Continued development of ab initio models of corrosion reactions. - Continued development of coatings capable of actively responding to environmental stresses. - Continued study of coating failure mechanism on coating-substrate interface. - Continued research on innovative concepts for effective radiation barrier coatings and ultra-low thermal conductivity barrier coatings. - Continued development of environmental corrosivity modeling. - Continued development of nanoscale modeling of corrosion kinetics. - Continued development of surface tolerant coatings. - Completed fundamental theoretical and experimental studies on nanoscale corrosion of metals and alloys. - Completed grain boundary engineering to improve corrosion resistance of marine grade aluminum alloys. Environmental Science					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations. - Continued broad based program in anti-fouling and fouling release coatings including investigation of effect of new polymers, materials, processes, and novel testing methodologies for coating efficacy. - Continued effort to determine most promising foul-release approaches based on silicones to meet Navy durability requirements. - Continued effort to develop Reverse Osmosis (RO) pre-treatment strategies to allow water recycling on ships. - Completed efforts on treatment strategies of oily water containing synthetic lubricants. Manufacturing Science - Continued a multidisciplinary research task into furthering the sciences associated with advances in manufacturing processes.					
FY 2017 Plans: Structural Materials - Continue all efforts of FY 2016, less those noted as completed above. - Complete investigation of processing science (single crystals, coatings, thermal barrier coatings (TBC), heat treatment, etc.) to materials performance for turbine engine components to develop relevant process protocols to optimize and control quality. - Complete research on new hybrid composites that integrate polymers, structural fibers, carbon nanotubes, ceramics and metals, with improved blast, ballistic, fire resistance and mechanical characteristics with special emphasis at the interfacial aspects of the new materials. - Complete structure and properties of liquid and glassy metals. - Initiate assessment of materials that incorporate directed energy, ballistic, and blast resistance for structural protection. Functional Materials - Continue all efforts of FY 2016. Maintenance Reduction - Continue all efforts of FY 2016, less those noted as completed above. Environmental Science - Continue all efforts of FY 2016, less those noted as completed above.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Manufacturing Science - Continue all efforts of FY 2016.					
FY 2018 Base Plans: Extramural Structural Materials Conduct basic research related to critical S&T for structural materials, including, but not limited to, the following: computer-aided materials design (CAMD), structural metals, polymer composite materials, solid mechanics, propulsion materials, sensors & NDE prognostics and structural cellular materials. Extramural Functional Materials Conduct basic research related to critical S&T for functional materials, including, but not limited to, the following: electronic materials, transduction materials, nanoparticles, bacterial nanowires and oxide materials. Expand research related to acoustic transduction science. Extramural Maintenance Reduction Conduct basic research related to critical S&T for maintenance reduction, including, but not limited to, the following: corrosion models, stainless steel carburization, corrosion, and coatings. Extramural Environmental Science Conduct basic research related to critical S&T for environmental science, including, but not limited to, the following: examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations, anti-fouling and fouling release coatings including investigation of effect of new polymers, materials, processes, and novel testing methodologies for coating efficacy, and Reverse Osmosis (RO) pre-treatment strategies. Expand research related to naval environmental science. Extramural Manufacturing Science Conduct basic research related to critical S&T for manufacturing science, including, but not limited to, the following: multidisciplinary research task into furthering the sciences associated with advances in manufacturing processes.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Intramural Undersea Warfare Conduct basic research focused on creating new techniques for detecting, visualizing, understanding, predicting, exploiting, and controlling the interactions between acoustic and elastic waves, structures, the fluid in which they are immersed, and other fields; building compliant based multifunctional material platforms for the advancement of acoustic sensors, receivers, and filters in underwater battle space environments; and enabling enhanced capabilities, such as passive signal modulation, larger acoustic attenuation in confined spaces, and structural overlays, that can render an otherwise opaque material transparent to acoustic propagation. This work strives to control and exploit the "structural acoustic" response of underwater structures for both stealth and sensor system applications and relates directly to the Navy's need for acoustic materials having improved performance for shallow water Anti-Submarine Warfare (ASW). Intramural Materials and Chemistry Conduct basic research in advanced materials which depends on novel synthesis, processing, characterization, and performance. This effort addresses all materials including metals, alloys, ceramics, composites, semiconducting and superconducting material and bimolecular materials. Studies include, to uncover the mechanisms in the nanometer scale, the effect of coatings on the conductions of iron and electrons. A key part includes developing a better understanding on the performance of spin-polarized electrons for advanced electronic switches and memories. Develop fundamental understanding of electron transfer pathways in microbial consortia and relate the indefinite power generation in benthic regions. Continue research into understanding the mechanism of the order of magnitude in advance composites consisting of soft polymers and nanoparticles with an effort to design advanced light weight armor. ***FY 2018 OCO Plans:*** N/A					
Title: MEDICAL/BIOLOGY	18.205	17.283	19.050	0.000	19.050
Description: Efforts include: This activity comprises efforts within the medical and biological sciences. These efforts are coordinated across the Tri-Service community through joint program reviews and meetings and are complementary, not duplicative. Efforts include: Bio-inspired autonomous and surveillance systems, and bio-inspired processes, materials and sensors; synthetic biology for Naval applications; casualty care and					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
management; casualty prevention; undersea medicine/hyperbaric physiology; biorobotics; expeditionary operations training; stress physiology and regenerative medicine Funding increase in 2018 is the result of increased research initiatives primarily in the area of Naval Biosciences and Synthetic Biology for Sensing & Energy Production. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Undersea Medicine- - Continued work on stress physiology, hyperbaric physiology, and biological effects of Naval operational exposures. - Continued work in understanding the mechanisms of decompression illness and hyperbaric oxygen toxicity. - Continued research to explore mechanisms of "ultrasonic" hearing in divers. - Continued interventions to mitigate underwater sound/blast effects. - Continued research on improved trauma management in submarine Special Forces operators. - Continued research on physiological and genetic effects of long-term diving. - Continued research on individual susceptibilities in extreme environments to include hypoxic and/or hypobaric conditions. - Continued research to assess the effects of hyperbaric oxygen therapy on blast-induced histopathological changes. - Continued research into the effects of hyperbaric environments on cellular biology (metabolism and signaling). Biomedical Sciences and Environmental Physiology- - Continued research in casualty care and management and casualty prevention, including investigations of mechanisms of hemorrhagic shock, blast injury, tissue repair, and the biomedical effects of military operational exposures such as directed energy, hazardous chemicals, and sound. - Continued research to explore systematic relationships between cognitive and physiological responses to laboratory tasks under operational conditions. - Continued research to explore a novel opioid that will produce analgesia as effective as morphine, with minimal side effects. - Continued research in genetic basis of psychological stress. - Continued research in mitigation of the effects of sleep deprivation. - Continued research in stress effects on the immune system.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research with Army, in regenerative medicine (Armed Forces Institute for Regenerative Medicine (AFIRM)). - Continued research to discriminate fatigue and stress performance effects. - Continued research to evaluate the effects of chronic stress on performance. - Continued research on individual susceptibilities on health and human performance in military environments to include heat, cold, enclosed spaces, pressure and acceleration. - Continued research on the mechanisms of nitrogen narcosis/high pressure nervous syndrome. - Continued investigations of mechanisms of blast-induced neurotrauma at the cellular level. - Initiated research in partnership with the Army to study regenerative medicine (Armed Forces Institute for Regenerative Medicine II (AFIRM II)). - Initiated research to investigate novel mechanisms to manage the mammalian circadian system for optimized health and performance. - Initiated research to develop strategies for nerve cell regeneration. Biological Sciences: Naval Biosciences- - Continued efforts focused on microbe-materials interfacial interactions for detection of materials defects/ failures, including corrosion, and for improved energy harvesting. - Continued efforts in "smart cell engineering" to design microbes that can sense and destroy other microbes through antibiotic production, or can "sense" and qualify their surrounding environment and provide information back to the user. - Continued research on biofouling with emphasis on barnacle adhesion studies using molecular biology tools. - Continued research on invertebrate larval settlement and metamorphosis in response to biofilms and various inhibitors of adhesion. - Continued efforts to identify molecular biomarkers for battlefield injuries, and high-fidelity biosensors for detection in vivo. - Continued research into biomolecular 'logic controllers' for in vivo biosensor and in vivo drug delivery systems. - Continued synthetic biology efforts for designing organisms with non-natural functions (e.g., light detection, electrical 'switch' capability, magnetic field production). - Continued research to identify natural product inhibitors of bacterial folate biosynthesis for development as antibiotics. - Continued studies to control the synthesis of patterned materials from the nano-scale to the micro-scale using bionanotechnology.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research on characterizing/manipulating human gut microbiome to understand its role in response to behavioral and physical stressors. - Continued research to integrate programmable, externally-controlled "sensor" cells into micro-robotic devices. - Continued research to characterize gut microbiota in real-time, in vivo. - Initiated research on tubeworm adhesion science using molecular biology tools. Life Sciences and Bioengineering- - Continued combinatorial chemical screens for bacterial communication pathway inhibitors as potential antibiotics or fouling control agents. - Continued work to identify plasma biomarkers of domoic acid toxicosis and leptospirosis in California sea lions, and develop a multiplexed assay to measure those plasma biomarkers. - Continued research on stem cells in marine mammals and their potential clinical role. - Continued development of a second set of molecular diagnostic tests for recently discovered viral pathogens of marine mammals. - Continued efforts to investigate DNA-scaffold-directed assembly of protein nanoarrays for control over orientation and position of proteins, and investigate triggered isothermal assembly of DNA nanostructures. - Continued efforts in comparing commensal/pathogenic microbiomes in to Atlantic bottlenose dolphin and California sea lion, and for the dolphin diagnosed with chronic/active gastritis. - Continued development of new tools and techniques for the engineering and characterization of DNA nanostructures and the control of DNA based nanodevices. - Continued the investigation of the material properties of silk proteins in order to facilitate development of applications. - Continued development of field portable sensing platforms for explosives detection. - Continued studies on environmental effects on marine invertebrate biofouling. Neural, Sensory and Biomechanical Systems- - Continued research efforts focused on developing bio-inspired sensors, vehicles and systems for local Intelligence, Surveillance and Reconnaissance (ISR), Weapons of Mass Destruction (WMD) detection, personnel protection and affordability. Research elements include advances in microfabrication, biological materials, processing techniques, robustness and efficiency of systems. - Continued research in elucidation of mechanisms of fish electric sense and near field low frequency acoustic perception.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research on bacterial/cellular controllers for nano/micro-systems.					
FY 2017 Plans: Medical Sciences Undersea Medicine- - Continue all efforts of FY 2016, less those noted as completed above. Biomedical Sciences and Environmental Physiology - Continue all efforts of FY 2016, less those noted as completed above. - Initiate research to investigate novel mechanisms to manage the mammalian circadian system for optimized health and performance. Combat and Operational BioMedicine - Continue all efforts of FY 2016, less those noted as completed above. - Initiate efforts to study injury mechanisms induced by underwater blast. - Initiate efforts to study bioderived systems to produce fieldable therapeutics. Biological Sciences Naval Biosciences - Continue all efforts of FY 2016, less those noted as completed above. - Initiate synthetic biology research in bioelectronics and information processing. Life Sciences and Bioengineering - Continue all efforts of FY 2016, less those noted as completed above. Neural, Sensory and Biomechanical Systems - Continue all efforts of FY 2016, less those noted as completed above.					
FY 2018 Base Plans: Medical Sciences: Undersea Medicine					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Conduct basic research into stress physiology, hyperbaric physiology, and biological effects of Naval operational exposure. Explore the mechanisms of decompression illness, hyperbaric oxygen toxicity and "ultrasonic" hearing in divers. Determine ways to mitigate underwater sound/blast effects. Improve trauma management in submarine Special Forces operators. Research the physiological and genetic effects of long-term diving including in extreme environments (hypoxic and/or hypobaric conditions). Assess the effects of hyperbaric oxygen therapy on blast-induced histopathological changes. Continue research into the effects of hyperbaric environments on cellular biology (metabolism and signaling). Biomedical Sciences and Environmental Physiology Conduct basic research to explore systematic relationships between cognitive and physiological responses under operational conditions. Research the effects of psychological and physiological stress, sleep deprivation and fatigue on the immune system and human performance. Investigate novel mechanisms to manage the mammalian circadian system for optimized health and performance. Research the mechanisms of nitrogen narcosis/high pressure nervous syndrome. Explore novel opioids with minimal side effects. Study bioderived systems to produce fieldable therapeutics. Develop strategies for nerve cell regeneration. Research regenerative medicine in concert with the Armed Forces Institute for Regenerative Medicine (AFIRM). Combat and Operations BioMedicine Conduct basic research in casualty care and management and casualty prevention, including mechanisms investigations of hemorrhagic shock, blast injury, tissue repair, and the biomedical effects of military operational exposure such as directed energy, hazardous chemicals, and sound. Explore health and individual performance under various military environments such as heat, cold, enclosed space, pressure and acceleration. Investigate the mechanisms of blast-induced neurotrauma at the cellular level, including underwater blasts. Initiate investigations of multi-scalar mechanisms of military occupational hazard and injury generation, detection, and repair, such as cavitation and directed energy. Biological Sciences: Naval Biosciences Complete basic research into tubeworm adhesion and marine biofouling. Investigate microbe-materials interfacial interactions for detection of materials defects/failures, including corrosion, and for improved energy					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
harvesting. Investigate "smart cell engineering" to design microbes that can sense and destroy other microbes and provide feedback to the user. Continue research on invertebrate larval response to biofilms and various inhibitors of adhesion. Identify molecular biomarkers for battlefield injuries, and high-fidelity biosensors for detection in vivo. Study biomolecular 'logic controllers' for in vivo biosensor and drug delivery systems. Research into synthetic biology to further efforts for designing organisms with non-natural functions (e.g., light detection, electrical 'switch' capability, magnetic field production). Identify natural product inhibitors of bacterial folate biosynthesis for development as antibiotics. Control the synthesis of patterned materials from the nano to micro-scale using bionanotechnology. Understand the role of human gut microbiome to behavioral and physical stressors. Integrate programmable, externally-controlled "sensor" cells into micro-robotic devices. Study synthetic biology bioelectronics and information processing. Initiate synthetic biology of gut microbes for warfighter resilience. Life Sciences and Bioengineering Complete the development of molecular diagnostic tests for recently discovered viral pathogens in marine mammals. Conduct basic research into combinatorial chemical screens for bacterial communication pathway inhibitors as potential antibiotics or fouling control agents. Identify plasma biomarkers of domoic acid toxicosis and leptospirosis in California sea lions, and develop a multiplexed assay to measure those plasma biomarkers. Research the potential clinical role of marine mammal stem cells. Investigate DNA-scaffold-directed assembly of protein nanoarrays for control over orientation and position of proteins, and investigate triggered isothermal assembly of DNA nanostructures. Compare commensal/pathogenic microbiomes in Atlantic bottlenose dolphin, California sea lion, and in dolphin diagnosed with chronic/active gastritis. Develop new tools and techniques to engineer and characterize DNA nanostructures and control DNA based nanodevices. Investigate the material properties of silk proteins to facilitate application development. Develop field portable sensing platforms for explosives detection. Study environmental effects on marine invertebrate biofouling. Neural, Sensory and Biomechanical Systems Conduct basic research into the development of bio-inspired sensors, vehicles and systems for local Intelligence, Surveillance and Reconnaissance (ISR), Weapons of Mass Destruction (WMD) detection, personnel protection and affordability including microfabrication, biological materials, processing techniques, robustness and systems					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
efficiency. Research the elucidation of mechanisms of fish electric sense and near field low frequency acoustic perception. Investigate bacterial/cellular controllers for nano/micro-systems. ***FY 2018 OCO Plans:*** N/A					
Title: OCEAN SCIENCES ***Description:*** Efforts include: The Ocean Sciences sub activity supports basic research in the ocean domain and the impact that this complex and changing environment has on naval operations. The effort encompasses research over a wide variety of regions, including the open ocean, Arctic, and littorals, and addresses scientific issues relevant to anti-submarine warfare (ASW) including acoustic propagation and the impact of acoustics on marine mammal behavior. The improved understanding of the ocean environment enables the development of fully coupled (ocean-atmosphere-wave-ice) global, regional and local predictive models that can be used for operational planning at tactical, strategic and climate scales. The program is strongly aligned with the Oceanographer of the Navy (N2/N6E) and the research topics addressed by this sub activity reflects the priorities for improved forecasts of the operational environment and the development and use of autonomous systems for the collection of environmental observations and continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable science at sea. Research performed under this Sub Activity includes efforts in the following areas: littoral geosciences and optics, marine mammals and biology, physical oceanography and prediction, and ocean acoustics. Accomplishments and plans described below are representative highlights from these efforts. Increase in 2016 is the result of initiation of several Department Research Initiatives in several oceanographic processes impact mission concerns. Decrease in 2017 is reflected by the decrease in investment in core Physical Oceanography. Funding increase in 2018 is the result of several increased research initiatives in the areas of Ocean Acoustics, Physical Oceanography Processes, Marine Mammals, and Littoral Geoscience and Optics. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Littoral Geosciences and Optics - Continued efforts to investigate the effects of oceanic biota on the propagation and inversion of multifrequency acoustical energy.	73.443	70.450	75.178	0.000	75.178

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued investigations of sources and properties of light scatter within the coastal ocean. - Continued to investigate and characterize the impact of riverine sources of optically-important matter on underwater visibility, navigation, and surveillance. - Continued effort to understand the extent and intensity of seafloor gas hydrate accumulations and coastal bio-optical response to air-ocean forcing. - Continued programs to estimate optical properties of coastal ocean water from above-surface sensing, using in situ data for validation. - Continued studies to predict tidal flat evolution in coastal/riverine/estuarine systems. - Continued incorporation of improved understanding of tropospheric and stratospheric bulk exchanges, air-sea interface, boundary layer interface, coastal ocean dynamics, gas hydrate accumulation, and biological responses into atmospheric and ocean prediction models and tactical aids. - Continued development of prediction models for distributaries deltaic coastal environments. - Continued field, modeling and remote sensing studies of currents, waves, sediment transport and bathymetric evolution of river mouth and inlet environments. - Continued investigations of radar, hyperspectral and electro-optical remote sensing signatures in littoral environments. - Continued development of a new method of data assimilation, adjointless 4D-Var through a combination of theoretical analysis and numerical simulations to develop the method and estimate its efficiency with respect to the traditional 4D-Var scheme as well as to use it to generate a sensitivity analysis for targeted observations. - Continued the effort to identify and isolate the dynamical processes that control the structure and variability of the Kuroshio and Ryukyu Current using a combination of numerical model simulations and observations and, explore their interactions between the Ryukyu Island passages. - Continued studies of Coupled Human-Landscape Interactions in Low-lying Coastal Environments. - Continued studies of data-assimilative modeling for coupled nearshore-riverine systems. - Continued the effort to understand and quantify the impact of land fluxes of freshwater and dissolved bio-optical constituents upon the diurnal and small-scale (days, meters to microstructure) coastal upper ocean response to atmospheric forcing. - Continued research efforts to observe, understand, and predict the many intertwined geophysical processes which are present on the inner shelf. Marine Mammals and Biology - Continued field trials of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals. - Continued new efforts on tracking of marine mammals using data fusion based on tags and remote sensing.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued new efforts to examine physiology of marine mammals in situ and to predict consequences of physiological and auditory stress to populations. Physical Oceanography and Prediction - Continued field studies/modeling to predict propagation and effect on acoustics of non-linear internal waves in the western Pacific. - Continued development of a ship wave radar driven wave model to allow high resolution studies of near surface ocean processes and to support Sea Basing. - Continued design evaluation for a persistent mobile sampling network based on autonomous undersea vehicle platform and sensor technologies. - Continued field programs that demonstrate persistent monitoring and measurement of environmental structures using gliders. - Continued workshops to define science needs for Sea Basing. - Continued an integrated modeling and field experiment on determining custom self-learning wave databases and forecast systems/ship-movement and engineering systems for Sea Basing. - Continued an Estuarine-Littoral Processes Interaction field study in muddy and tidal flat dominated regimes including a data assimilative prediction capability. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas. - Continued studies to understand how to sample ocean processes with gliders and other autonomous and remote sensing systems to support tactical oceanography. - Continued to develop state of the art numerical model assimilation and initialization techniques, improved physical parameterizations, air-sea interactions, and fidelity for atmospheric and ocean prediction systems. - Continued development of expert system methods to characterize and predict Riverine/estuarine systems to support Naval Special Warfare, Marine Expeditionary Forces and new Riverine units. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued studies of ocean and wave response to typhoons and monsoons in the Western Pacific. - Continued studies of how to predict the 'full battle space environmental cube' using networked sensors and multiply coupled ocean/wave/atmosphere/acoustic prediction systems to provide Seabase and Fleet/Force protection. - Continued extensive 3-year field program on prediction of internal waves.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics program. - Continued an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued the field and modeling experiments to determine the lateral dispersion and maxing parameterization needed to understand model turbulence and to model ocean circulation. - Continued an effort to understand the dynamics that govern spiciness variability, its impact on ocean circulation, and the competing roles temperature and salinity have on ocean density and sound speed structure evolution. - Continued a field and modeling effort to understand and predict the generation and variability of western boundary currents in the Pacific Ocean. - Continued a field and modeling effort to understand the coupled physical processes that result in the propagation of the air-sea mode known as the Madden-Julian Oscillation in the Indian Ocean. - Continued a field and modeling program to investigate the structure and circulation of the South China Sea and oceanographic variability along the coast of Vietnam. - Continued studies of the coupled atmosphere-ocean-cryosphere-wave physics from the submesoscale to decadal climate scales to permit development of new global coupled modeling systems. - Continued studies of changes in the Arctic oceanography, meteorology and cryosphere and associated processes to allow permit development of new prediction models for the Arctic. - Continued arctic research to develop a new generation of ocean-ice-atmosphere dynamic prediction models, including process studies involving remote sensing and in-situ observations. - Continued collaborative studies with Vietnam to observe and model oceanographic processes along the Vietnamese shelf. - Continued field experiments using autonomous vehicles to observe topographically-generated currents and turbulence around islands in the Western Pacific Ocean. - Continued research efforts related to the development of an Earth System Prediction Capability to enable improvements in extended range environmental forecasts. - Continued the effort to understand the relative importance of key physical processes governing the attenuation of wave energy in the marginal ice zone (MIZ). Study results will contribute to improved understanding of these processes for applications in spectral wave and general circulation models (GCMs). - Continued research efforts to observe, understand, and predict the evolution of the Marginal Ice Zone in the Arctic Ocean.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued in situ, airborne, and remote sensing observational efforts to inform scientific studies of the physical environment in the Arctic region. - Continued research on integrated Arctic System Models to enable improved forecasts of the operational environment on lead times from hours to months in the Arctic domain. - Continued an investigation into the changing surface conditions of the Arctic Ocean, resulting from observed reductions in sea ice cover. - Initiated research on extreme currents and highly variable flow generated by flow encountering abrupt topography in the Western Pacific. - Initiated research on the structure and variability of the Northern Arabian Sea circulation using autonomous, unmanned sampling systems in order to provide critical basic understanding. Ocean Acoustics - Continued analysis of deep-water acoustic transmissions made in the North Pacific to understand the scattered sound field due to ocean volume variability and bathymetric features. - Continued a field and modeling effort to simultaneously study shallow-water medium fluctuations and develop time reversal communications using adaptive channel equalizers. - Continued shallow-water, shelf-break measurements and analysis to characterize the effects of the ocean water column and seabed variability on low- and mid-frequency acoustic propagation and scattering. - Continued a field and modeling effort to establish the capabilities of underwater acoustic communications for FORCEnet and persistent undersea surveillance. - Continued the development and testing of geo-acoustic inversion and extrapolation methods. - Continued investigations into quantifying, predicting and exploiting uncertainty in acoustic prediction models. - Continued research to develop complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. - Continued research to quantify uncertainty in acoustic field computations for multi-scale ocean environments using novel approaches involving Bayesian prediction and polynomial chaos expansions to embed environmental uncertainty into multiscale ocean dynamics and acoustic propagation. - Continued data collection and analysis of deep water ambient noise with emphasis on the Philippine Sea. - Continued reverberation and clutter modeling studies. - Continued investigation of acoustic propagation in the Arctic. - Continued soft sediment geoacoustic inversion studies with an emphasis on the Gulf of Mexico.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated geoacoustic inversion studies with an emphasis on the New Jersey and Arctic Shelves.					
FY 2017 Plans: Littoral Geosciences and Optics - Continue all efforts of FY 2016, less those noted as complete. - Complete studies of Coupled Human-Landscape Interactions in Low-lying Coastal Environments. - Initiate research efforts to observe, understand and predict coastal land-air-sea interactions and identify needed improvements in operational databases and coupled land-air-sea modeling resolutions, formulations and implementations. - Initiate research efforts to model the time-varying shallow-water acoustical environment on HPC resources and to evaluate these models with field data and underwater remote sensing systems. Marine Mammals and Biology - Continue all efforts of FY 2016. Physical Oceanography and Prediction - Continue all efforts of FY 2016, less those noted as complete. - Complete studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas. - Complete studies of ocean and wave response to typhoons and monsoons in the Western Pacific. - Complete workshops to define science needs for Sea Basing. - Complete extensive 3-year field program on prediction of internal waves. - Complete extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics program. - Complete the field and modeling experiments to determine the lateral dispersion and maxing parameterization needed to understand model turbulence and to model ocean circulation. - Complete an effort to understand the dynamics that govern spiciness variability, its impact on ocean circulation, and the competing roles temperature and salinity have on ocean density and sound speed structure evolution. - Initiate a modeling and autonomous observation study of the Northern Arabian Sea using floats, gliders, and drifters. - Initiate field experiments to investigate changes in Arctic stratification and circulation and related physical processes in the Beaufort and Chukchi Seas. - Initiate a multidisciplinary field effort to characterize and understand air-sea-land interactions over the Maritime Continent in the western Pacific and the impact on intra-seasonal variability and extended-range prediction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Ocean Acoustics - Continue all efforts of FY 2016, less those noted as completed above. - Complete research to develop complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. - Complete research to quantify uncertainty in acoustic field computations for multi-scale ocean environments using novel approaches involving Bayesian prediction and polynomial chaos expansions to embed environmental uncertainty into multiscale ocean dynamics and acoustic propagation. - Completed soft sediment geoacoustic inversion studies with an emphasis on the Gulf of Mexico. - Initiate geoacoustic inversion studies with an emphasis on the New Jersey and Artic Shelves.					
FY 2018 Base Plans: Extramural Physical Oceanography and Prediction Conduct research on ocean variability generated by flow encountering abrupt topography in the Western Pacific; Carry out field experiments to investigate changes in Arctic stratification and circulation and related physical processes in the Beaufort and Chukchi Seas. Carry out a multidisciplinary field effort to characterize and understand monsoon intra-seasonal variability in the Indian Ocean. Finish analysis from a study of the structure and variability of the Northern Arabian Sea circulation using autonomous, unmanned sampling systems. Extramural Littoral Geosciences and Optics Complete all efforts from previous fiscal years. Initiate development of methodologies and/or observing technologies which are: a) nimble, cost-effective, rapidly re-locatable, or will offer bold insight into littoral dynamics, or b) utilize sensors on operational platforms (termed organic) in ways which increase battlespace awareness or can be used to map the maritime domain while idle. Initiate studies and modeling of shelf, near-shore, delta, estuarine, and riverine dynamics, including surface and internal waves, currents, stratification, sediment transport and the seabed response and coastal winds driving shallow water response. Understanding shallow water features which will affect acoustic propagation or acoustic system performance and/or events which cause swimmer or navigational hazards (bathymetry-wave-current-wind interactions), navigationally significant bathymetry or trafficability changes, are of particular interest. Initiate studies using remote sensing of the coastal and riverine environment, above and below the sea surface and canopy, e.g., from EO, IR, radar, SAR, inSAR and acoustic, from land or ship-based, unmanned vehicles, airplanes or satellites. New remote					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
sensing tools and algorithms that can be used to initialize forecast models in distant, remote and/or denied areas are of particular interest. Initiate studies of optical processes in the littoral environment, including the atmosphere, sea surface, water column, sea bed and suspended or dissolved materials. Predicting the timing (initiation, transport and clearance) of materials that negatively affect optical clarity, is of particular interest. Extramural Marine Mammals and Biology Integrated Ecosystem Research - Conduct basic research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Initiate a multidisciplinary approach using tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields. Investigate using animal tagging and passive acoustic monitoring to study behaviors and distributions of marine mammals relative to key environmental properties (biotic and abiotic). This includes providing a context for interpreting behavioral responses to external stimuli (i.e. anthropogenic sound), and providing basic knowledge needed for predictive models of species of concern. Effects of Sound - Conduct basic research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. Initiate research to characterize the causal chain of events leading from sound exposure to "biologically significant" behavioral reactions that might increase risks of population-level effects and/or the potential for stranding. An additional focus is to characterize the gas management and kinetics (stores and use) in marine mammals. Conduct research into the mechanisms that enable marine mammals to dive to deep depths for long durations while mitigating, if not avoiding, health threats. Initiate research to advance our understanding of sound reception mechanisms in mysticetes (large whales) will require a thorough exploration of the anatomy surrounding the ear and the whole head combined with modeling sound propagation through various tissues of whale heads and/or bodies. Another research focus is better understand the stress response in marine mammals to sound exposure. Conduct research to develop an understanding of the natural variation of stress markers, better understand and characterize the relationships among hormones or other biomarkers in different matrices, define and compare the quantitative and temporal relationships of hormones across the different matrices, and evaluate and characterize the relationship between the physiological stress response in marine mammals and acoustic exposure and 'biologically significant' disturbance. Continue research to develop statistical models of the population consequences of acoustic disturbance to be fitted to data from marine mammal populations and lead collaborative development of transferable models of the effects of disturbance on marine mammals.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Monitoring and Detection - Conduct research to develop and test new and existing technology to detect and classify marine mammals in the marine environment and during periods of low light such as passive acoustics, and IR. Continue research and development of passive acoustic signal processing algorithms for detection, classification, and localization of marine mammals. Continue the development and testing of autonomous hardware platforms using passive acoustics and/or IR to detect and classify marine mammals using a variety of fixed, towed, floating, and profiling platforms. Extramural Ocean Acoustics Conduct research to understand propagation and scattering of acoustic energy in shallow-water ocean environments. Areas of research include: shallow-water scattering mechanisms related to reverberation and clutter; seabed acoustic measurements supporting geoacoustic inversion; acoustic propagation through internal waves and coastal ocean processes and the development of unified ocean/seabed/acoustic models, including scattering from rough surfaces, biologics and bubbles; and penetration/propagation within the porous seafloor. Intramural Battlespace Environments The overall objective of this research is to improve basic understanding of physical, seafloor and biological oceanographic processes on space and time scales of naval interest. Emphasis is on improved measurements, laboratory and model based experiments to quantify and understand important oceanographic processes that lead to the development of ocean dynamic models from global to submesoscale scales, and to couple these oceanographic models with atmospheric, ice, biological, sediment response, and optical models. Surveillance of coastal land areas and waters is important to support Navy operations and difficult. The Navy/Marine Corps needs include an improved use of overhead (airborne and satellite) active and passive microwave sensors, overhead optical sensors, surface-based (ships and ground-based) grazing angle microwave sensors. To predict bottom boundary physical, geological, geochemical, geoacoustic and geotechnical properties in shallow-water operating areas requires: a) an improved understanding of processes that generate and modify the shape, structure and physical properties of the seafloor, subseafloor, ocean water column and ice-cover and topography/morphology; b) use of rapid, airborne characterization of littoral environments including time-varying coastal topography, littoral bathymetry, sea-level height, land and seafloor sedimentary structures to explain/ predict the observed changes; c) remote sensing of bulk properties of Arctic sea-ice over broad two-dimensional areas that previously could be sampled only at spot locations by in-situ sampling; and d) quantification of the					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
influence of turbulence generated at the seafloor boundary layer on vertical mixing and stratification in shallow water outside the surf zone. ***FY 2018 OCO Plans:*** N/A					
Title: SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH ***Description:*** Science and Engineering Education and Career Development activities include DON participation in science fairs, summer research interns/fellows at Navy laboratories, graduate fellowships for individuals expected to become members of the engineering faculty at Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs), and curricular enrichment programs. It is centered on Naval S&T efforts supporting Science, Technology, Engineering and Math (STEM). Outreach includes the encouragement, promotion, planning, coordination and administration of Naval Science and Technology. Funding also supports ONRG International Science Program whose mission is to search the globe for emerging scientific research and advanced technologies to enable the Office of Naval Research and the Naval Research Enterprise to effectively address current needs of the Fleet/Forces, and investigate and assess revolutionary, high-payoff technologies for future naval missions and capabilities. This is accomplished through PhD-level Associate Director scientists located in Asia, Europe and South America collaborating with international organizations and researchers through grants in innovative basic research, and establishing quality, relevant connections between international science and technology (S&T) centers of excellence and DON, DoD, and other US Government organizations. The direct impact of this investment is to capitalize on international basic research during unprecedented and dynamic global interdependence, increasing the ability to solve DON S&T challenges through shared knowledge and technologies with partners during a time of budget constraints. Additionally, this investment builds global S&T awareness to reduce the risk of potential technological surprise, and supports theater security cooperation goals to sustain cooperative relationships with an expanding set of international partners to enhance global security. Funding increase in 2018 is the result of increased research initiatives in the areas of STEM and International Outreach. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Science, Technology, Engineering and Math (STEM)	47.105	46.115	49.752	0.000	49.752

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued awarding prizes at 400 regional high school science fairs and four national competitions For Inspiration and Recognition of Science and Technology (FIRST), Junior Science and Humanities Symposia (JSHS), and Association for Unmanned Vehicle Systems International (AUVSI). - Continued supporting high school summer interns at Navy laboratories Science and Engineering Apprentice Program (SEAP). - Continued supporting undergraduate/graduate students as summer research interns at Navy laboratories Naval Research Enterprise Internship Program (NREIP). - Continued providing graduate fellowship support to HBCU engineering faculty candidates. - Continued funding Young Investigator Program (YIP) research grants. - Continued inspiring, engaging, educating and employing exceptional candidates to sustain and enhance the naval research enterprise. - Continued funding for the following educational and outreach efforts: Youth Exploring Science (YES), American Society of Materials (ASM) Teacher Camp, Expanding Your Horizon (EYH), Forest Partners, and Sally Ride Science, plus SeaPerch, FIRST, and BotBall robotics efforts. - Continued support for SciGirls, Navy GEMS (Gains in the Education of Mathematics and Science), STEM Literacy for Navy recruits, Business-Higher Education Forum (BHEF), and the Gulf Coast Initiative. - Continued new projects to further teacher development and Grades 13/14 STEM degree retention. - Continued new effort on undergraduate retention in STEM majors at Minority Serving Institutions. - Continued new effort for teacher training in STEM for schools in underserved communities. - Continued new computer science programs for female undergraduates. - Continued expansion of internships to underserved students. - Continued Masters in Systems Engineering program at a minority institution in partnership with Assistant Secretary of the Navy (Research, Development and Acquisition). - Continued to refocus STEM outreach and education efforts towards demonstrated Navy and Marine Corps workforce needs and away from areas of responsibility delegated to the National Science Foundation, the Department of Education, and the Smithsonian Institution. - Continued to emphasize and expand the NREIP and SEAP summer internship programs. International Outreach - ONR Global - Continued international outreach support through ONR Global that provides a conduit for new scientific areas on the international front and promotes foreign sources of research important to the Naval mission.					
FY 2017 Plans: Science, Technology, Engineering and Math (STEM)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2016. International Outreach - ONR Global - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Science, Technology, Engineering and Math (STEM) Initiate STEM initiatives and multi-year efforts that are intended to be approximately three years in length and in topics supporting STEM education relevant to naval science and technology workforce development by improving STEM education curriculum enrichment and student experiences in higher education and high schools, coordination and support of STEM efforts across DON, and participation of naval personnel in science fairs. International Outreach - ONR Global ONR Global will support 26 PhD level scientists engaging with international scientists and engineers through liaison visits to research institutions in more than 60 countries. ONR will be establishing a new office in India. ***FY 2018 OCO Plans:*** N/A					
Title: SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW)	46.459	46.907	49.758	0.000	49.758
Description: Efforts include the basic research portions of: sensing, diagnostics, and detectors; navigation and timekeeping; nanoelectronics; wide band gap power devices; real-time targeting; Electro-Optical/Infra-Red (EO/IR) electronics; EO/IR electronic warfare; EO/IR sensors for surface/aerospace surveillance; Radio Frequency (RF) sensors for surface/aerospace surveillance; solid state electronics; vacuum electronics; and RF electronic warfare. Funding increase in 2018 is the result of increased research initiatives in the areas of Intramural Electromagnetic Warfare and Intramural Electronics. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued monolithic integration of multifunctional materials to enable passive devices and sensors into wide bandgap semiconductor circuits. - Continued investigation of physical basis for improved time and frequency standards using quantum-entangled ions and atoms. - Continued investigation of ultra-high speed logic and multiple-quantum-well devices with a goal of >500 gigahertz (GHz) samplers, in support of mixed signal circuits for receiver analog-to-digital converters (ADC's). - Continued program to extend device performance and architectures to frequencies approaching terahertz (THz). - Continued program to incorporate Magnesium Diboride (MgB2) tunnel junctions into simple electronic logic structures. - Continued study to determine if the coupling between spins in quantum dots mediated by the virtual excitons is sufficiently strong for use in solid state implementations for quantum information. - Continued program on advanced epitaxial growth for novel Si-based detector applications. - Continued development of a blind adaptive beamforming approach for the High Frequency (HF) radar case and compare with both the conventional and traditional approaches. - Continued development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. - Continued development of electromagnetic ultra-near-field holography. - Continued development of sensitive miniature fluxgate magnetometers. - Continued projects to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging. - Continued a program to apply innovative mass nanofabrication techniques to previously developed nanodevice arrays. - Continued a program on the control of deleterious defects in silicon carbide (SiC). - Continued a program on the study of Quantum Dots and their application to coherent wave function control and quantum information. - Continued a program on the tailoring of the optical, structural and electronic properties of semiconductor quantum wires. - Continued a program to demonstrate non-volatile memory, based on spin-torque Magnetic Random Access Memory (MRAM), with switching speed > 1 GHz and write currents small enough (<1 mA) to be driven by superconducting Rapid Single Flux Quantum (RSFQ) logic. - Continued a program to determine if the newly invented Reciprocal Flux Quantum Logic in fact delivers 2x higher speeds with 5x fewer Josephson junctions and power, while using the same underlying devices so that single chip hybrid circuits between it and the dominant RSFQ logic are feasible.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued demonstrations of tunable analog filters made in a digital Nb device foundry. - Continued work on optical manipulation of ultra-cold atoms. - Continued investigation of temporal-spatial noise shaping circuits and architectures for high power digital-to-analog conversion with objectives of doubling spectral bandwidth, reduction of element density (15%), and extension of multidimensional Nyquist limits to both linear and planar arrays. - Continued the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processor (DSP) applications to Transmit/Receive (T/R) arrays. - Continued research to improve mixed signal III-V device and circuit modeling with objectives of achieving a 30 dB dynamic range improvement for complex circuits containing over 100,000 devices. - Continued project to explore graphene based nanoelectronic devices. - Continued program in chip-scale quantum architectures. - Continued project to reduce heat transfer through electrical leads in cryogenic packaging. - Continued project to explore development of devices, sigma delta and time encoder circuits for near THz switching with objectives of enabling analog and digital conversion at millimeter wave frequencies. - Continued high-sensitivity magnetometry using quantum logic. - Continued materials studies of low temperature regenerator (high thermal capacity) materials and/or controlled flow microstructures with the goal of improving energy efficiency of cryocoolers. - Continued research into fundamental concepts and mathematics for digital array architectures. - Continued research to apply carbon nano-tube technology to acoustic sensing. - Continued research to investigate two-dimensional electron gases in perovskite oxide heterostructures. - Continued project to investigate self-assembled one-dimensional GaN channels in AlGaN/GaN structures. - Continued spin-based electronics research. - Continued graphene physics and bandgap engineering research. - Continued work on spin properties of graphene. - Continued research effort to determine the most appropriate tunnel barrier for MgB2 Josephson junctions. - Continued an effort to grow low defect density, high purity epitaxial 4H-SiC at high growth rates suitable for high power electronic device applications. - Continued design, construction, and testing of sonic crystals that can be tuned to have specific acoustic properties. - Continued effort to create a physics-based understanding of epitaxial oxides and insulators for use in applications for advanced electronics. - Continued investigation into stabilizing in-phase coherent state of coupled systems for coherent power generation. - Continued high output impedance solid state device technologies and materials.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued effort to fabricate functionalized micro-opto-mechanical systems for the measurement of micromechanical photothermal spectra of adsorbed chemical vapor analytes. - Continued research effort on chemical synthesis and bandgap tailoring in graphene nanoribbons. - Continued research on spin dynamics in Group IV semiconductors and related device concepts. - Continued research efforts on non-conventional nanofabrication that hold promise for sub-10nm resolution. - Continued studies of the physics origin of noise and behavioral fluctuations in superconducting circuits, especially analog to digital converters, and incorporate the understanding into computer aided circuit simulators. - Continued studies of the generation and recombination dynamics of non-equilibrium quasiparticles associated with digital switching events in superconducting logic. - Continued investigation of metamaterials with embedded active devices to better understand multidimensional signal processing from RF through THz frequencies. - Continued effort on nuclear optical frequency standard in Thorium 229. - Continued studies of intraband transitions in wide bandgap quantum wells. - Continued studies of the use of non-linear optical (phonon-photon interactions) phenomena as a method of cooling to cryogenic temperatures. - Continued effort to investigate statistical representations of target and signal techniques. - Continued research on defect engineering and characterization in graphene. - Continued studies of how to prevent flux trapping and diagnose its occurrence in complex superconducting circuits and to design real time expert measurement systems in general for testing of new designs defined in VHSIC (Very High Speed Integrated Circuits) Hardware Description Language (VHDL). - Continued MgB2 Josephson junction work with first tests of 10 device logic cells to determine likely clock speeds of this new materials technology. - Continued high output impedance solid state amplifier technologies. - Continued program of ultraprecise gravitational measurements using atom interferometers. - Continued research on graphene based high performance flexible electronics. - Continued research on DNA based carbon nanotube sorting and placement. - Continued investigation of electrical stress characterization and Gallium Nitride transistor stability. - Continued development of a path-integral-based theory of wave propagation in bounded, disordered media. - Continued effort to develop multiple layered semiconductor quantum dots for infrared optical applications. - Continued research on characterization and control of graphene edge effects. - Continued research on electronic functionality in DNA nanostructures. - Continued research on chemical functionalization and self-assembly of graphene nanostructures.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued studies of how best to densitify superconducting circuits using new third generation Nb devices including what new layers devoted to resistors, filters, power distribution or wiring would provide the greatest system benefit. - Continued research on correlated electron materials for high performance electronic devices. - Continued effort to study novel oxide materials with high electron densities for high performance transistors. - Continued research on synthesis of electronic Boron Nitride films. - Continued research on defect characterization of single layer Boron Nitride. - Continued studies of analog intelligent nanoelectronics computational architecture. - Continued research on new class of superconductors or devices in which competition between superconducting and magnetic ordering is involved. - Continued research on multi-THz electromagnetic devices lying within the intersection of high-speed electronic materials, photonic materials and active metamaterials. - Continued research on semiconductor nanowire array based transistors operating in the quantum capacitance limit for highly linear RF electronic devices and photonic nanoresonators. - Continued research on 2D materials other than graphene. - Continued research on chemical synthesis of carbon nanostructures. - Continued research towards detecting and manipulating Majorana fermions in condensed matter systems. - Continued studies of topological insulator materials and novel device concepts exploiting properties of transport in their protected electronic state. - Continued efforts to improve the sensitivity of superconducting quantizers, mechanisms to achieve >20 GHz in-building wireless (IBW) in analog to digital converters, and explore origins of non-linearities in quantizers. - Continued studies of whether superconducting qubits can act as controllable sources of microwave entangled photons and whether these plausibly have application to quantum radar. - Continued study of active control of biomolecular binding on surfaces. - Continued search for sustainable replacements for semiconductors and strong magnets. - Continued study of sensing, selection and control of marine microbes. - Continued effort to develop techniques for the atomic layer deposition of high-quality dielectric films on semiconductor surfaces with extremely low interface state densities. - Continued effort to determine the feasibility and develop a greater understanding of defect science in SiC epitaxial layers on low offcut substrates suitable for power electronic applications. - Continued fundamental investigation onto the synthesis and material properties of graphene, boron nitride and other two dimensional materials; identify potential exploitation avenues. - Continued development of the method of moments solvers for millimeter wave region targets - Continued development of phase-only pattern synthesis for transmit arrays.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of a new theory of inference for statistical signal processing. - Continued research to control quantum dot excitations by using acoustic phonons. - Continued development of mathematical and numerical tools to understand stochastic prediction and control of delay coupled dynamical systems. - Continued effort to develop novel Interfacial Misfit (IMF) & Selective Area Pillar (SAP) techniques for molecular beam epitaxy (MBE) growth of non-lattice matched III-Sb alloys with low defect densities & favorable band alignments for a new generation of IR optical devices. - Continued effort to develop mid-, far-infrared and terahertz nanophotonic optical components using optic phonon modes within polar dielectrics. - Continued research on optical and plasmonic properties of graphene in infrared (IR) and terahertz (THz) spectral regions. - Continued effort to maintain the ten (10) femto-second jitter produced by high speed long Josephson junction (LJJ) clocks as these pulses propagate to their point of use in coherently sampling multiple ADC and devise a Josephson junction based way of phase locking a LJJ clock to an external master clock. - Continued non-equilibrium k-space transport studies. - Continued research on micro plasma based materials, devices, and circuits. - Transferred studies of analog intelligent nanoelectronics computational architecture. - Transferred research on optical and plasmonic properties of graphene in infrared (IR) and terahertz (THz) spectral regions. - Transferred research on 2D materials other than graphene. - Transferred research on chemical synthesis of carbon nanostructures. - Transferred research towards detecting and manipulating Majorana fermions in condensed matter systems. - Transferred studies of topological insulator materials and novel device concepts exploiting properties of transport in their protected electronic state. - Transferred research on spin dynamics in Group IV semiconductors and related device concepts. - Transferred research efforts on non-conventional nanofabrication that hold promise for sub-10nm resolution. - Transfer research on defect engineering and characterization in graphene. - Completed research on duel-STM characterization of graphene film. - Completed studies of chemical vapor deposition (CVD) of graphene on copper. - Completed research on spin properties in topological insulators.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete research on heterojunction bipolar transistors with diamond collectors.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete research on optical modulators using vanadium oxide. - Complete research on phosphorene field-effect transistors. - Complete research on transistors based on lanthanum-doped barium tin oxide. - Initiate research on chalcogenide-based phase-change materials for photonics. - Initiate research on improved thermal conductivity and contact resistance of germanium telluride for RF switches. - Initiate research exploiting non equilibrium k-space transport in electronic devices for high efficiency signal generation and information processing. - Initiate research exploiting avalanche transport phenomena in wide bandgap materials and devices.					
FY 2018 Base Plans: Extramural SEEW Continue basic research in the areas of solid state transistors and devices for high frequency analog and digital operation; high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications; superconducting and other technologies which are designed to deliver software defined, wide band, simultaneous signal functionality for conventional system contexts, including, but not limited to, SATCOM, Surveillance, Electronic Warfare (EW), signal intelligence (SIGINT), and communications; electronics and photonics technology that provides for the control, reception, transmission and processing of signals; and continue research to advance navigation, timekeeping and sensing technology, including cooling and trapping of atoms and ions; Bose-Einstein condensation and coherent matter- wave physics; optically-based frequency standards; improved time and frequency metrology using quantum entanglement and quantum logic processing; quantum optomechanics; and coherence and control of quantum systems. Intramural Undersea Warfare Conducted research focused on using a broad spectrum of techniques, including acoustic holography, new optical/electrical/magnetic measurement technologies, phonon transport measurement and control, and advanced numerical methods. Investigates physical phenomena related to acoustic propagation in oceanic environments that exhibit variations in impedances, sound speeds, density, sedimentation, bathymetry, and oceanography to improve system prediction performance, sonar processing, and to discover novel concepts for ASW. The work relates directly to the Navy's need for thermoelectric power generation, devices and systems having improved performance for shallow water Anti-Submarine Warfare (ASW), acoustic and electric signature measurement and control, and energy generation.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Intramural Electromagnetic Warfare Fundamental research is being conducted looking at revolutionary mechanisms for advance tracking techniques for the joint battle space. A very novel concept of using radars for long range speech reception and playback is ongoing. RCS prediction capabilities for naval vessels is being researched to cover ultra-wide bandwidths, significantly expanding our predictive narrow band capabilities. When coupled with another developmental effort on multistatic radar theory will provide a broad perspective of target signatures essential to defining radar and EW performance requirements. Intramural Materials and Chemistry Design novel experiments and theoretical models to create advanced or improved materials using new concepts and techniques for applications and sensors and advanced electronics. For applications to improve target identification algorithms utilizing non linier dynamics to understand and demonstrate the principles and mechanisms of DNA-based molecule-scale machines to amplify detection of biochemical agents. Fabricate single normal layer of materials to create monolayer ferromagnets and semiconductors. The material of choice will be single layer MoS2 for utilization as indirect gap semiconductors. The NRL unique single stage accelerator mass spectrometer to evaluate the fine scale detection limits of fusion products and isotopes. Understanding of the protein-surface interactions will be directed to fabricate biosensors. First principle theoretical models are developed to understand the principles governing the interactions between surfaces and small molecules. Intramural Electronics Create new knowledge and understanding and explore new concepts, components, techniques and methods, for the design, growth, and characterization of electronic, electromagnetic, and electro-optical materials, fabrication processes, electronic and electro-optic components, including novel electromagnetic concepts and techniques, and plasma phenomena and theory. ***FY 2018 OCO Plans:*** N/A					
Title: WEAPONS	18.209	18.252	18.925	0.000	18.925

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: Efforts include: undersea weaponry; energetic materials and propulsion; expeditionary operations (communications, materials for forensic sensing, landmine detection, human sensory enhancements, lightweight power sources and information efficiency); counter directed energy and applied electromagnetics. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. Accomplishments and plans described below are examples for each effort category. ***FY 2016 Accomplishments:*** Undersea Weaponry - Continued conducting basic research related to critical S&T (including vehicle control, maneuverability, and stability) associated with the development of High-Speed Supercavitating Vehicles (HSSV). - Continued expansion of the Navy Undersea Research Program (NURP) Program to provide a further infusion of educated and career minded scientists and engineers in support of the National Naval Responsibility (NNR) for Undersea Weapons Research. - Continued evaluation of viable synthesis methodologies and characterization of candidate explosive ingredients suitable for undersea weapons applications. - Continued studies metalized explosives, lattice deformation of crystalline explosives, high thermal conductivity nanocomposites for vehicle arrays, microplasma fuels reforming and biomimetic propulsion mechanisms for underwater vehicles exploiting flutter instability. - Continued validation of hydroacoustics models and test and evaluate acoustic array signal processing algorithms. - Continued study on propulsion and its interaction with supercavitating cavity, and control surfaces. - Continued acoustic concepts formulation and modeling for low-noise bio-inspired propulsion systems. - Continued high energy density power system research for under water vehicles. - Continued concept development on inversion of swarm dynamics for underwater tactical applications. - Continued development of diagnostic capabilities to accurately determine aluminum combustion characteristics in oxidizing environments. - Continued an Otto Fuel II characterization study for undersea weapons.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued basic research related to cavity stability, vehicle control, maneuverability, stability associated with the development of high-speed, supercavitating vehicles. - Continued new, and continue on-going, research in fusing phenomenology, reactive materials, high oxygen constituents and insensitive munitions and use of these technologies in advanced warhead concepts. - Completed new coating concepts for corrosion and anti-fouling protection of UUVs. - Completed computer code refinements and investigation of supercavitating vehicle dynamics and instability. Energetic Materials and Propulsion - Continued development of a fundamental understanding of initiation mechanisms of explosive crystals subjected to shock stimulus. - Continued exploring the use of quantum mechanics and molecular dynamics to provide fundamental properties for energetic materials to predict initiation/detonation criteria for insensitive munitions applications. - Continued investigation of JP-10 combustion-based Proton-Exchange-Membrane (PEM) fuel cells. - Continued investigation of multi-tube multi-nozzle Pulse Detonation Engines (PDEs) and multi-tube common nozzle PDEs. - Continued investigation of nanometallic-hydrocarbon hybrid catalytic combustion for increased energy release rates. - Continued investigation of novel initiation techniques, including optimized injection parameters, and integrated single tube operation for PDEs. - Continued Advanced Energetics research in reactive, explosive, and propulsive energetic materials, including high energy ingredient synthesis & characterization, and fundamentals of initiation and decomposition mechanisms, to tailor energy release processes in order to achieve substantial performance gains and/or enhanced survivability in harsh environments. - Continued to develop fundamental understanding of nitramine and perchlorate decomposition mechanisms for propellant applications. - Continued to develop organometallic-based highly energetic ingredients. - Continued efforts to explore alternative fuel concepts for Naval applications to include hydrogen, synthetic diesel, and biodiesel. - Continued development of multi-parameter sensor for multi-phase combustion flows (UAV and underwater PDEs). - Continued implementation of new & nanostructured materials design concepts for direct energy conversion and waste energy conversion. - Continued investigation of integrated pulse detonation engine-airframe for autonomous vehicles, and pulse detonation for passive weapons (noise, jamming).					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C). - Continued hydroacoustics models and experiments to reduce the self-noise on cavitator acoustic array. - Continued acoustic signal processing algorithms for HSSV guidance and control. - Continued development of new concepts for underwater power generation. - Continued development of non-lethal undersea warheads for Overseas Contingency Operations. - Continued development of PDE for underwater applications. - Continued new thrust on the design, synthesis and characterization of high energy dense oxidizers. - Continued structure property relationship studies on advanced propellant systems and high blast energetic compositions. - Continued synthesis and characterization of cluster complexes between reactive metals and energetic oxidizers and explosives. - Continued research and development for hypersonic propulsion system technologies for increased range and speed, improved stealth and maneuverability, reduced emissions and signatures, lower noise, wider operational envelopes and turndown ratio. - Continued research into coulombic explosives via unique electronic and structural properties of atomic clusters not observed in bulk. - Continued development of a new methodology coordinating both theoretical and synthetic chemistry to maximize molecular design and predicted molecule stabilities facilitating insight into the next generation of energetic materials. - Continued research to develop ability to synthesize and quantitatively predict energetic material performance from first principles of quantum chemistry. - Continued research and development on aircraft, fuels and rocket propulsion system technologies for increased range and speed, improved stealth and maneuverability, reduced emissions and signatures. - Continued an investigation that focuses both theoretical and synthetic processes to maximize molecular design and crystal morphology for new insensitive munition (IM)-compliant commodity energetic material ingredients. - Initiated hypersonic aerodynamics, aerothermodynamics and high temperature materials research focused on challenges resulting from unique Navy platform constraints. Expeditionary Operations - Continued investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells. - Continued basic materials research to explore and improve high strain and stress rate performance of high performance fibers, armor inserts, and structural materials.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued basic research into automated reasoning and data fusion for distributed surveillance. - Continued fundamental chemistry and materials science research to advance water purification technologies. - Continued basic research to advance electrochemical energy conversion and storage. - Continued a Vehicle Autonomy effort focused on unmanned and autonomous systems to displace the operator from hazardous conditions/environments, lighten the load of individual Marines, and provide greater warfighting capability. - Continued a new effort to research peer-to-peer mixed initiative planning to allow unmanned autonomous systems to collaborate and improve their common operating picture without having to have a human in-the-loop. - Continued Distributed Trust Models effort to determine USMC S&T gaps hindering dominance in cyberspace. - Continued development of collection strategies based on cutset sensor topologies in order to provide enhanced situational awareness with sparse sampling. Counter Directed Energy - Continued investigating the most promising physics, science, and mathematic solutions to protect naval assets against directed energy threats. - Continued establishing the basic science and technology issues relevant to the propagation of directed energy in the atmosphere and its interaction with sensors, electronics and structural materials. - Continued assessment of theoretical constructs for directed energy (DE) systems detection and geolocation. - Continued investigation into the susceptibility of critical naval electronic components to electromagnetic radiation. - Continued development of courseware for Counter Directed Energy (CDEW) for use at the U.S. Naval Academy and the Naval Postgraduate School. - Continued performance of laboratory experimentation on laser and High Power Microwave protection methods for future naval aviation systems and platforms. - Continued development of suitable metamaterial samples which provide electromagnetic shunting and conduct laboratory testing with laser and microwave systems. - Continued testing of unmanned systems DE protection methods. Applied Electromagnetics: - Continued program to conduct basic research and theoretical analysis in electromagnetic phenomena in the spectrum from microwaves to visible light. Areas of research will be in microwave directed energy, optical directed energy (lasers), terahertz sources, and related nanometer-scale electronics and sensors.					
FY 2017 Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Undersea Weaponry - Continue all efforts of FY 2016, less those noted as completed above. Energetic Materials and Propulsion - Continue all efforts of FY 2016, less those noted as completed above. Expeditionary Operations - Continue all efforts of FY 2016, less those noted as completed above. - Complete a Vehicle Autonomy effort focused on unmanned and autonomous systems to displace the operator from hazardous conditions/environments, lighten the load of individual Marines, and provide greater warfighting capability. -Complete investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells. - Initiate Dynamical Information Processing for Autonomous Systems. - Initiate expeditionary basic research efforts in computer science, human-social-cultural interactions and data science related to distributed systems. Counter Directed Energy - Continue all efforts of FY 2016, less those noted as completed above.					
FY 2018 Base Plans: Undersea Weaponry Conduct basic research related to critical S&T for undersea weapons and supercavitation. Expand research related to the Undersea Weapons initiative to provide a further infusion of educated and career minded scientists and engineers in support of the National Naval Responsibility (NNR) for Undersea Weapons Research. Energetic Materials and Propulsion Conduct basic research into the science of energetic materials and advanced propulsion technology. Researched advanced energetic material which provide reactive, explosive, and propulsive phenomena including high energy ingredient synthesis, modeling, characterization, and the fundamentals of initiation and decomposition mechanisms. Program has explored the bounds of energy management between conventional electron bonding energies and that of nuclear binding energies. Current investigations focus on both theoretical					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
and experimental processes using molecular design and crystal morphology theory for the selection of new insensitive munition (IM)-compliant commodity energetic material ingredients. Investigate development of a new methodology coordinating both theoretical and synthetic chemistry to maximize molecular design and predicted molecule stabilities facilitating insight into the next generation of energetic materials including research to develop ability to synthesize and quantitatively predict energetic material performance. Pursue research into sub-nano scale molecular systems and the energetic phenomena including initiation techniques, novel nozzle, tube and flow approaches, and sensing and propulsive control technology. Investigating efforts to explore alternative fuel concepts for Naval applications to include hydrogen, electric propulsion, synthetic diesel, and biodiesel. Conduct basic research into solid rocket motor system technologies for increased range, speed, improved stealth, and maneuverability. Pursuing research into Rotating Detonation Engines (RDEs) and their application to air vehicles and weapons including detonation initiation techniques, low-loss combustor isolation, fuel-air mixing, tube and flow approaches, and sensing and control technology. Expeditionary Operations Transfer all efforts of FY 2017 to the Sciences Addressing Hybrid Threats Activity within this same Program Element. Counter Directed Energy Conduct research into the basic science and technology issues relevant to the propagation of directed energy in the atmosphere and its interaction with sensors, electronics and structural materials. Pursue investigation of the most promising physics, science, and mathematic solutions to protect naval assets against directed energy threats. Execute an assessment of theoretical constructs for directed energy (DE) systems detection and geolocation. Current research pursues the investigation into the susceptibility of critical naval electronic components to electromagnetic radiation. Conduct performance of laboratory experimentation on laser and High Power Microwave protection methods for future naval aviation systems and platforms. ***FY 2018 OCO Plans:*** N/A					
Title: BASIC RESEARCH CHALLENGE ***Description:*** The ONR Basic Research Challenge (BRC) program was established in 2008 to competitively select and fund promising research programs in new areas not addressed by the current basic research	20.794	19.082	21.396	0.000	21.396

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
program. The program stimulates new, high-risk basic research projects in multidisciplinary and departmental collaborative efforts, and funds topics that foster leading edge science and attract new principal investigators and organizations. Basic Research Challenge awards are for a period of four years. Topics are submitted by ONR program officers and are selected for BRC awards by ONR's director of research. Basic Research Challenge award topics are then issued as a broad agency announcement. Funding increase in 2018 is the result of the increased number of topics of research initiatives in the area of Basic Research Challenges. ***FY 2016 Accomplishments:*** - Continued research into the science of autonomy. - Continued research into de-centralized on-line optimization. - Continued research into carbon molecular electronics. - Continued research into co-prime sensor array signal processing: a new framework for reduced complexity sensing. - Continued research into understanding and characterizing intuition for more effective small unit decision making training technologies. - Continued research into couplings of ocean to space of ionospheric drivers . - Continued research into biologically inspired flow field computation for sensing and control of ground vehicles. - Continued research into reduced order representations for design: development of optimized algorithms for multi-physics based models. - Continued research into multi-scale nonlinear mechanisms and effects associated with coupling weak energy into composite explosive compounds. - Continued research into integration of advanced analysis with materials research. - Continued research into towards active control of noise from hot supersonic jets. - Continued competition for new BRC awards to address selected high priority Naval S&T areas, transformational initiatives, and grand challenges, including strategically important DON research areas. Approximately four high priority research topics will be identified to solicit proposals. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those completed in that year. ***FY 2018 Base Plans:*** Continue Basic Research into, high-risk multidisciplinary research areas including: autonomy, de-centralized on-line optimization, carbon molecular electronics, co-prime sensor array signal processing, small unit decision					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
making training, biologically inspired flow field computation, algorithm optimization for multi-physics based models, composite explosive compounds, advanced analysis techniques for materials, and active supersonic jet noise control. Initiate basic research topics in emerging fields of science including: multiscale theory for cavitation in complex soft materials; phase-resolved bottom-side IONosphere (BSION); decentralized perception in data-rich dynamic environments; enhanced manufacturability with electrical currents; distributed sensing, actuation and control in soft materials for flexible appendages; predictive and causal modeling; and new opportunities to transform wall-bounded turbulence understanding. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	435.563	422.748	458.333	0.000	458.333

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Defense Basic Research seeks to improve the quality of defense research conducted predominantly through universities and government laboratories. It also supports the education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in an academic environment. Initial research focus is generally conducted in an unfettered environment because of the nature of basic research, but as more is learned and applications emerge, individual research projects take on a more applied focus. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. Example metrics include a biporous wick structure for thermal management of power electric modules capable of removing 900 watts per square centimeter which was recently developed by an academia/industry team. The National Research Council of the National Academies of Science and Engineering's congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	53.103	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	53.103

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	53.103	0.000
FY 2016 Accomplishments: Expand and further basic research efforts to support Navy and Marine Corps needs in the following areas: Autonomous Systems; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach).		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	53.103	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602114N *I Power Proj Applied Research*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	88.940	41.371	13.553	-	13.553	17.736	17.739	17.818	18.054	Continuing	Continuing
0000: *Power Proj Applied Research*	0.000	71.078	41.371	13.553	-	13.553	17.736	17.739	17.818	18.054	Continuing	Continuing
9999: *Congressional Adds*	0.000	17.862	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.862

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board. This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/ asymmetric warfare.

This PE supports both advanced technology research and near to mid-term transition opportunities. The advanced research focus is primarily on directed energy, high speed weapon propulsion, and electro-optic/infrared (EO/IR) sensor technologies.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	87.223	41.371	39.925	-	39.925
Current President's Budget	88.940	41.371	13.553	-	13.553
Total Adjustments	1.717	0.000	-26.372	-	-26.372
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.873	0.000			
• SBIR/STTR Transfer	-1.156	0.000			
• Program Adjustments	0.000	0.000	-26.372	-	-26.372
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602114N *I Power Proj Applied Research*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	13.034	0.000
Congressional Add: *Force Protection Research*	4.828	0.000
Congressional Add Subtotals for Project: 9999	17.862	0.000
Congressional Add Totals for all Projects	17.862	0.000

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the Solid State Laser - Technology Maturation (SSL-TM) and Electro Magnetic (EM) Railgun programs to the newly established program element 0602792N Innovative Naval Prototypes.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602114N / *Power Proj Applied Research*	Project (Number/Name) 0000 / *Power Proj Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Power Proj Applied Research*	0.000	71.078	41.371	13.553	-	13.553	17.736	17.739	17.818	18.054	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project addresses the technology issues involving the Navy's capability to project naval power on the broad seas and in the littoral regions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: DIRECTED ENERGY	27.806	10.956	4.556	0.000	4.556

Description: The goal of this activity is to develop Directed Energy (DE) technology for Navy applications. The DE program addresses the requirements of future Navy combatants to provide ship defense against the emerging threats that are proliferating throughout the Navies of the world. The Directed Energy portion of this activity consists of two elements.

FY 2016 to FY 2017 decrease in funding is due to Solid State Laser Maturation Program (SSL-TM) program entering the fabrication and testing phase.

Effective in 2018, the SSL-TM funding moves to the new innovative naval prototype (INP) PE - 0602792N Innovative Naval Prototypes.

FY 2016 Accomplishments:
Directed Energy and Accelerator Research:

-Continued to develop the most promising component technologies such as normal conducting and super conducting RF electron beam injectors, advanced high power cathode technologies, high power compact amplifiers, and advanced mirrors, coatings and optical components capable of handling the significantly higher energies for potential alignment in a Free Electron Laser.

Solid State Laser - Technology Maturation (SSL-TM):

-Continued the development of technologies suitable for a solid state laser weapon system, including technologies for maritime beam director, targeting and laser subsystems, which are capable of supporting future Navy missions to defeat small boat swarms, UAV swarms, and provide potential ISR disruption and/or defeat.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
This work supports future prototype developments and will include laser subsystem (potentially both slab and fiber solid state systems) and required beam director scientific studies. The focus of the effort will be to support the development and advancement of future Navy Solid State Laser prototypes, including the development of lethality studies and atmospheric characterization. These scientific studies are critical to understand and support missions identified for a layered defensive capability, in the maritime environment, which shall include robust modeling and simulation of atmospheric absorption and turbulence. -Conducted lethality testing for notional solid state laser designs. This will include scientific studies of laser erosion, pitting, and ablation of various target materials for improved modeling and simulation that will support development of the governing technical requirements for a beam director and targeting system capable of performing Navy surface ship self-defense missions. -Continued studies of atmospheric absorption and turbulence, suitable to evaluate notional maritime beam director subsystems, and including studies in adaptive optics for improved lethality performance in low altitude, maritime surface conditions. These scientific studies are critical to understanding the impact of boundary layer and sea-water-air turbulent mechanics on future laser weapons systems and interfaces. -Continued trade studies on innovative solid state laser subsystems designs, based off industry available technologies or those technologies identified by the High Energy Laser Joint Technology Office (HEL JTO). These investments will be considered "break through" type of investments, which require additional scientific study to determine their potential for near term capability improvements in a future naval prototype system. -Continued scientific studies on laser subcomponents, including laser pump diodes and laser gain media, which have the potential to support future acquisition programs, but are based on solid state laser technologies. Efforts in this area will focus on emerging commercial technologies and government sponsored research, which are suitable for use in a maritime domain. Research and technology developments will include advancements suitable for use by either solid state slab or solid state fiber optic laser subsystems - and which if matured, would enable rapid scientific advancements and improve specific systems performance against key performance parameters. -Continued scientific trade studies of notional predictive avoidance systems, which examine the control interfaces between sensors and future prototypical naval laser weapons, which would provide an inherent "safe-arm" function for the projection of laser power at long range (potentially beyond typical visible, line of sight distances.) Of particular concern is the designs for safety in future laser weapons to halt laser energy propagation, while performing Navy surface ship self- defense missions, and avoid inadvertent illumination of non-threat forces (e.g. friendly sensors or platforms.) -Conducted component and subcomponent laboratory tests.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Conducted Preliminary Design Review (PDR) for Tactical Laser Core Module (TLCM).					
FY 2017 Plans: Directed Energy Research: -Continue all efforts of FY 2016 unless noted as completed above Solid State Laser - Technology Maturation (SSL-TM): - Continue all efforts of FY 2016 unless noted as completed above. - Conduct Critical Design Review (CDR) for Tactical Laser Core Module (TLCM) planned during FY 2017					
FY 2018 Base Plans: Directed Energy Research: Initiate research in component technologies and basic understanding of laser/material interactions to enable higher power, more lethal High Energy Laser, high power Microwave/Radio Frequency, and Ultra Short Pulse Laser weapons capabilities. Some examples of research include the development of novel laser and beam directory architectures, improved sensor and illuminator technologies including materials and coating, improved HEL electrical to optical efficiency, improved laser sources with enhanced spectrum control, reduced system jitter and improved precision aim point maintenance. Other research areas that will be explored are the syntheses of target recognition, pose/trajectory estimation, autonomous aim point selection and maintenance including tracking through intermittent viewing conditions such as waves and clouds, understanding atmospheric characterization and modeling tools, blooming, laser/material/target interactions, novel laser sources in MWIR-LWIR (4-12 microns), USPL propagations and synergistic effects of USPL with HEL beams. Research will continue in Counter Directed Energy Weapons (CDEW), in response to the development of high energy laser (HEL) and high-power microwave (HPM)/high-power radio frequency (HPRF) threats. Complete effort to develop a fiber based high power laser operating in the eye safe regime beyond 2 microns Electronics (NRL) Develop & apply innovative S&T in plasmas, pulsed power, electromagnetic acceleration, particle beams, high-energy & ultra-short-pulse lasers (USPL), and non-linear optics to support current and future Navy and DoD needs.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Solid State Laser - Technology Maturation (SSL-TM): - Effective 2018, SSL-TM effort is realinged to the new innovative naval prototype (INP) PE - 0602792N Innovative Naval Prototypes. ***FY 2018 OCO Plans:*** N/A					
Title: HIGH SPEED PROPULSION AND ADVANCED WEAPON TECHNOLOGIES	3.905	3.813	4.712	0.000	4.712
Description: The high speed weapons work in this activity is focused on demonstrating propulsion and vehicle technologies for Mach3+ to Mach8 capable weapons. This work includes technologies associated with high acceleration capable projectile structures, high temperature and high strength materials to enable projectiles to survive high speed launch environment, improved thermal prediction methodologies and test techniques, wide dynamic pressure adaptable projectile controls and non-explosively launched lethal mechanisms. The high speed projectile technologies are intended to support long range Naval Surface Fire Support weapons. The increase in FY2018 is due to increased investment in Hypersonic Propulsion. ***FY 2016 Accomplishments:*** -Continued high speed hypersonic weapons technology program to provide exploratory development of enabling very long range hypersonic boost-glide missiles and hypersonic ship-launched projectiles. -Continued development of advanced computational and experimental techniques for hypersonic boundary layer transition. -Continued High Temperature thermal management research. -Continued Ultra-high temperature materials research for hypersonic leading edges and nose tips. -Continued technology maturation of advanced airframes and controls, high G-force components and miniaturization of electronics. -Continued effort to develop advanced guidance and control technologies for high speed weapons. -Continued high temperature capable thermal management, insulator and ablative technology investigations. -Continued high speed propulsion and integrated airframe technology development to enhance system range, responsiveness and reliability. -Continued investigations into advanced material solutions to high speed airframes and air systems operating in maritime environments.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Transitioned the Hyper Velocity Projectile (HVP) program to an FNC. ***FY 2017 Plans:*** -Continue all efforts of FY 2016 unless noted as completed above. ***FY 2018 Base Plans:*** -Examples of current investments include topics relevant for development of high speed/hypersonic aerodynamics technologies to support exploratory development to enable very long range hypersonic boost-glide missiles and hypersonic ship-launched projectiles. Specific research and development plans include: development of very long range hypersonic boost-glide missiles and hypersonic ship-launched projectiles; advanced computational and experimental techniques for hypersonic boundary layer transition; high temperature thermal management research; ultra-high temperature materials research for hypersonic leading edges and nose tips; technology maturation of advanced airframes and controls; high G-force components and miniaturization of electronics; advanced guidance and control technologies for high speed weapons; insulator and ablative technology investigations; high speed propulsion and integrated airframe technology development to enhance system range, responsiveness, and reliability; and advanced material solutions to high speed airframes and air systems operating in maritime environments. ***FY 2018 OCO Plans:*** N/A					
Title: NAVIGATION, ELECTRO OPTIC/INFRARED (EO/IR), AND SENSOR TECHNOLOGIES ***Description:*** This activity describes Navy Science and Technology (S&T) investments in the areas of Electro Optic/Infrared (EO/IR) devices and advanced sensors and includes investment/performance in the technology areas of EO/IR, Electronic Warfare (EW)and Electromagnetic Warfare , and Communications. FY 2016 to FY 2017 increase is due to ramp-up of EW Sensor Technology. FY 2018 decrease is due to the completion of EW Electro Optic/Infrared efforts. ***FY 2016 Accomplishments:*** Electronic Warfare: -Initiated development of methodology to concatenate nanoparticle structures for spectral control of obscurant material	4.659	5.755	2.555	0.000	2.555

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Continued development and prove a method of more efficiently transporting EW sensors using a low Reynolds Number regime boundary layer control system. -Continued development of a water assisted take-off process for electronic warfare sensors. -Continued development of advanced fuel cell technology for UAS to increase on-station time of EW sensors. -Continued efforts for Unmanned Aerial System (UAS) Based EW: The objective is to develop a System of Systems (SoS) able to artificially create the appearance of a realistic naval force to many adversary surveillance and targeting sensors simultaneously. It will benefit the warfighter by providing battle space confusion to adversary surveillance and targeting systems both above and below water, creating seamless cross-domain countermeasure coordination, and enabling rapid advanced technology/capability insertion to counter emerging threats. Technology developments will include reconfigurable and modular EW payloads, Distributed Decoy and Jammer Swarms (DDJS), effective acoustic countermeasures (CM), and Multiple Input/Multiple Output Sensor/ CM (MIMO S/CM) for false force generation to both above and below water sensors. -Continued development of ultra-low noise uncooled nanotechnology infrared sensors. -Continued development of nanoatomic sensor nonvolatile memories. -Continued development of electronic field of view and zoom imagers. -Continued the development of an active optics system that can survey a wide area and instantly, nonmechanically zoom-in on an area of interest for target tracking/identification. -Continued development of new processes/methodologies to enable construction of composite countermeasures that fit the engagement timeline while maintaining effectiveness against existing and emerging IR guided threats. -Continued effort to develop mid & long wave IR focal plane arrays using graded-band gap W-type-II. Superlattices with much higher detectivity than that of state-of-the-art HgCdTe (MCT). -Continued development of next generation IR focal plane sensor and countermeasures to defeat it. -Continued research to apply manifold modeling and optimal control techniques to airborne EO/IR sensor systems. -Continued development of novel photovoltaic and autonomous soaring technology to enable long range EW sensor delivery systems Electro Optic/Infrared: -Continued development of next generation IR focal plane sensor and countermeasures to defeat it. -Continue research to apply manifold modeling and optimal control techniques to airborne EO/IR sensor systems.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Completed development of structured dielectric elastomers for electromechanical devices and deformable optics. -Completed development of magneto-optic materials and ultra-high sensitivity, room-temperature magnetic field sensors. ***FY 2017 Plans:*** Electronic Warfare: -Continue all efforts of FY 2016 unless noted as completed above. -Complete development of advanced fuel cell technology for UAS to increase on-station time of EW sensors. Electro Optic/Infrared -Complete development of next generation IR focal plane sensor and countermeasures to defeat it. -Complete research to apply manifold modeling and optimal control techniques to airborne EO/IR sensor systems. ***FY 2018 Base Plans:*** Electronic Warfare: -Continue all efforts of FY 2017 unless noted as completed above. -Complete development of novel photovoltaic and autonomous soaring technology to enable long range EW sensor delivery systems. -Complete development of methodology to concatenate nanoparticle structures for spectral control of obscurant material. Electro Optic/Infrared: -Conduct multiple efforts of EO/IR threats through both active and passive countermeasures technologies and assuring deployment capabilities are available to achieve the proper disposition of materials for extended durations. Electronics					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Create and explore new concepts, components, techniques, and subsystems for the detection of UV, visible, and infrared radiation to support current and future Navy and DoD needs. ***FY 2018 OCO Plans:*** N/A					
Title: STRIKE AND LITTORAL COMBAT TECHNOLOGIES ***Description:*** The focus of this activity is on those technologies that will support Naval Precision Strike Operations and provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. The increase in FY 2018 reflects the increased investment at the Naval Research Laboratory in Advanced Radio Frequency/Electro-Optical (RF/EO) Sensor & Seeker Technology research. ***FY 2016 Accomplishments:*** Increased Capability Against Moving and Stationary Targets: -Continued the development and demonstration of new Electronic Protection (EP) techniques that can discriminate advanced jamming false targets from true targets and also suppress false targets so that true targets can be readily detected. -Completed development of multi-static electronic protection techniques against advanced jamming systems. Enhanced Weapon Technologies: -Continued three new products to expand current Counter Air / Counter Air Defense capabilities by providing improved range and end-game maneuverability while decreasing Time-of-Flight. Specific tasks to begin design and development phase are: Counter Air Advanced Medium-Range Air-to-Air Missile (AMRAAM) Improvements / Counter Air Defense / Improvement / High Speed Components. -Continued development and applied emerging technologies that support delivery of Technology Oversight Group approved FNC enabling capabilities structured to close operational capability gaps in power projection; package emerging power projection technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period; and mature power projection technologies that support naval requirements identified within the Sea Strike and FORCEnet naval capability pillars.	0.763	0.909	1.730	0.000	1.730

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Strike Accelerator: -Continued Strike Accelerator program. This effort will provide an advanced airborne capability to accurately identify targets using Advanced Target Recognition (ATR). These capabilities are utilizing the F/A-18 E/F, AESA (Active Electronically Scanned Array) Radar and ATFLIR (Advanced Targeting Forward Looking Infrared) sensors. Multi-Target Laser Designator: - Continued research for advanced optical techniques to defeat SWARM attacks. Selectable Output Weapon: -Continued Selectable Output Weapon Sea Strike Project. High Energy Fiber Laser System: -Continued development an advanced laser beam control, pointing mechanism and power subsystem to support an airborne laser weapon system. This system will provide the detection and defeat of current and future threats. ***FY 2017 Plans:*** -Continue all efforts of FY 2016 unless noted as completed above. ***FY 2018 Base Plans:*** Continue all efforts of FY 2016/2017 unless noted as completed above. Conduct applied research in Advanced RF/EO Sensor & Seeker Technologies for Navy and Marine Corp operations and systems. Electromagnetic Warfare (NRL): Technology development is ongoing to address capabilities to understand the defeat mechanism for operations of ISR platforms using non-traditional frequencies as well as protecting current capabilities against electronic attack through enhanced concepts. The non-traditional integration of ISR capabilities is being implemented into a major Commercialization Pilot Program (CPP) funded effort at NRL to validate expectations at minimal cost to this program and expand the capability of a significant testing resource. ***FY 2018 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: ELECTROMAGNETIC GUNS	33.945	19.938	0.000	0.000	0.000
Description: This activity is the Electro Magnetic (EM) railgun program that is focused on developing the technology to launch a long range projectile from Navy ships. EM railgun is being considered for multi-mission applications including USMC Naval Surface Fire Support, anti-surface warfare (ASUW) and ship self defense from missiles and small boat threats. The FY 2016 to FY 2017 funding decrease reflects the completion of majority of long lead barrel buys with continued barrel testing required. The FY 2017 to FY 2018 funding decrease reflects the realignment of the Electro Magnetic (EM) Railgun program to the new innovative naval prototype (INP) PE 0602792N Innovative Naval Prototypes. ***FY 2016 Accomplishments:*** -Continued additional next generation pulsed power fabrication as part of a multi-module, multi-year build to increase full scale rep rate capability from 20MJ to 32MJ muzzle energy capability. -Continued effort to understand the technology required to launch hypervelocity projectiles in only a 4 meter long barrel at 10 rounds per minute. -Continued launcher development -Continued material, physics and thermal property research for single shot launchers, pulsed power and projectiles for 32MJ muzzle energy launch; and initiated assessments from next generation, rep rate, and operational environments. -Continued IPT and Bore Life Consortium collaborations for 32 MJ launchers. -Continued material applications and component design assessments for next generation repetitive fires. -Continued development of modeling and simulation capability to support bore life development and testing for rep rate bore life development assessments. -Continued pulsed power development and fabrication required to support repetitive rate testing. ***FY 2017 Plans:*** -Continue all efforts of FY 2016 unless noted as completed above. -Complete majority of long lead barrel buys with continued barrel testing required. -Complete effort to understand the technology required to launch hypervelocity projectiles in only a 4 meter long barrel at 10 rounds per minute.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Complete additional next generation pulsed power fabrication as part of a multi-module, multi-year build to increase full scale rep rate capability from 20MJ to 32MJ muzzle energy capability. ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	71.078	41.371	13.553	0.000	13.553

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE develops early components technologies that can be integrated into weapon systems that meet warfighter requirements. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments). The metrics used to evaluate 6.2 programs are necessarily less precise than those used in 6.3 programs.

The metrics for this PE can be divided into two categories: technological and organizational/functional. Technological metrics address the success of the work performed. The primary technological metrics used in this PE involve laboratory experiments/tests demonstrating proof of the concept for the technology. This demonstration is frequently a hand-assembled functioning breadboard of the concept. The organizational/functional metrics applied to this PE include: transition of the technology to advanced development in a 6.3 PE and applicability of the technology to documented warfighter problems or requirements. Successful implementation of these categories would result in the application of a pass/fail metric and further evaluation for possible transition to a 6.3 development/demonstration program.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602114N / *Power Proj Applied Research*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	17.862	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.862

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase ***FY 2016 Accomplishments:*** Additional funds will be utilized towards researching efforts to develop high energy weapons. These could potentially include Electromagnetic Railgun (EMRG) development and directed energy initiatives. Increased investments in the Electro Magnetic (EM) railgun would go towards the further development of a weapon which could be considered for multi-mission applications including USMC Naval Surface Fire Support, anti-surface warfare (ASUW) and ship self-defense from missiles and small boat threats. Funds used towards the development of Directed Energy (DE) technologies for Navy applications will go towards addressing requirements of future Navy combatants to provide ship defense against emerging threats that are proliferating throughout the Navies of the world. ***FY 2017 Plans:*** N/A	13.034	0.000
Congressional Add: Force Protection Research ***FY 2016 Accomplishments:*** Investments in the Electro Magnetic (EM) railgun would go towards the further development of a weapon which could be considered for multi-mission applications including USMC Naval Surface Fire Support, anti-surface warfare (ASUW) and ship self-defense from missiles and small boat threats. Funds used towards the development of Directed Energy (DE) technologies for Navy applications will go towards addressing requirements of future Navy combatants to provide ship defense against emerging threats that are proliferating throughout the Navies of the world. ***FY 2017 Plans:*** N/A	4.828	0.000
Congressional Adds Subtotals	17.862	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 9999 / *Congressional Adds*

D. Acquisition Strategy

N/A

E. Performance Metrics

Congressional Interest Items not included in other Projects.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602123N *I Force Protection Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	174.447	158.745	125.557	-	125.557	124.007	121.863	121.922	124.398	Continuing	Continuing
0000: *Force Protection Applied Res*	0.000	155.137	158.745	125.557	-	125.557	124.007	121.863	121.922	124.398	Continuing	Continuing
9999: *Congressional Adds*	0.000	19.310	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.310

A. Mission Description and Budget Item Justification

The efforts described in this program element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability. This is accomplished by improvements in platform offensive performance, stealth, and self-defense.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	178.616	158.745	164.678	-	164.678
Current President's Budget	174.447	158.745	125.557	-	125.557
Total Adjustments	-4.169	0.000	-39.121	-	-39.121
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.233	0.000			
• SBIR/STTR Transfer	-3.936	0.000			
• Program Adjustments	0.000	0.000	-39.121	-	-39.121

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602123N *I Force Protection Applied Res*	

• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

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

	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Alternative Energy Research*	19.310	0.000
Congressional Add Subtotals for Project: 9999	19.310	0.000
Congressional Add Totals for all Projects	19.310	0.000

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the Autonomous Aerial Cargo/Utility System project, the Joint Tern programs, and the Medium Displacement Unmanned Surface Vehicle (MDUSV) effort to the new innovative naval prototype program element 0602792N Innovate Naval Prototypes.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602123N / *Force Protection Applied Res*	Project (Number/Name) 0000 / *Force Protection Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Force Protection Applied Res*	0.000	155.137	158.745	125.557	-	125.557	124.007	121.863	121.922	124.398	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability by virtue of improvements in platform offensive performance, stealth, and self-defense.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: AIRCRAFT TECHNOLOGY	68.638	65.452	39.461	0.000	39.461
Description: The Aircraft Technology activity develops technologies for reduced observables technology and enhanced capability of naval aviation aircraft platforms in terms of mission effectiveness, platform range, responsiveness, survivability, observability, readiness, safety and life cycle cost. It also develops new Naval air vehicle concepts and high impact, saleable naval air vehicle technologies, such as - autonomous air vehicle command and control, helicopter and tilt rotorsystems, aerodynamics, propulsion systems, materials, structures and flight controls for future and legacy air vehicles. Variable Cycle Advanced Technology (VCAT) will identify and mature critical, relevant variable/adaptive cycle propulsion system technologies for the next generation carrier-based Tactical Aircraft (TACAIR)/Intelligence, Surveillance and Reconnaissance (ISR) systems. Autonomous Aerial Cargo/Utility System (AACUS) will develop advanced autonomous capabilities to enable rapid resupply of distributed forces in the short term. The Sea-Based Aviation National Naval Responsibility (SBA NNR) Structures and Materials program will develop the next generation structural capability and material response science for aircraft technology in fixed and rotary wing, manned and unmanned airframe technology to achieve reduced weight, increased durability, strength, streamlined manufacturability, reduced life-cycle cost and maintenance/readiness gaps improvements. Program payoffs include increased availability/readiness, reduced sustainment requirements, fatigue/loads life enhancement, reduced weight and improved range, and advanced prognostics design tools.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
These efforts addresses unique attributes to propulsion and power technologies for Naval Aviation, as well as those having higher importance to Naval Aviation and some that are more pervasive to all of military aviation. Related basic research efforts are addressed under 0601153N Defense Research Sciences. The funding decrease from FY 2016 to FY 2017 is due to maturation of AACUS technology applied research effort. The funding decrease from FY 2017 to FY 2018 is due to AACUS and joint Tern programs moving to new innovative naval prototypes PE 0602792N Innovative Naval Prototypes. ***FY 2016 Accomplishments:*** - Continued new efforts on high confidence/Safe Autonomous Control in naval environments and on supervisory control of decentralized heterogeneous UAS. - Continued SBA NNR related projects in Virtual Ship/Aircraft Dynamic Interface, Manned/Unmanned Handling Qualities and Control, Automated Deck Operations, High Lift Aerodynamics and Vertical/Short Takeoff and Landing (V/STOL) Operations. - Continued applied research efforts under the Sea-Based Aviation National Naval Responsibility Propulsion thrust area. - Continued development of rotorcraft/VTOL systems automated launch and recovery technology. - Continued mixed-mode mechanical/environmental failure prediction research. - Continued advanced composite durability technology. - Continued material degradation risk prediction and operational environment-driven materials selection methods. - Continued demonstration of initial core software, sensor, air vehicle, and capability applications for Autonomous Aerial Cargo/Utility System (AACUS). - Continued the advanced technology demonstration portion of the Variable Cycle Advanced Technology (VCAT) Program. Critical technology development efforts will begin with major engine manufactures and system contractors to develop/mature the highest priority, long-lead propulsion system technologies, including variable/ adaptive cycle engine components, for next generation carrier-based TACAIR/ISR systems. - Continued VCAT Phase I variable cycle engine/propulsion subsystem technology development efforts through completion. - Continued to explore and evaluate future aircraft concepts and their associated enabling technologies. - Continued development of survivability/reduced observables technology. Metrics are classified.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued new efforts on safe-perception based autonomous control in complex naval environments and on autonomy to support combined unmanned and manned air systems/units. - Continued airplane launch and recovery component and subsystem technology developments to enable medium size long endurance, long range UAVs to be launched and recovered on short deck ships. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Pursue research related to Sea-Based Aviation (SBA) National Naval Responsibility (NNR) priorities in Aviation, Propulsion, and Structures and Materials. - Examples of research in Aircraft Technology include efforts in Virtual Ship/Aircraft Dynamic Interface, Manned/ Unmanned Handling Qualities and Control, Automated Deck Operations, High Lift Aerodynamics and Vertical/ Short Takeoff and Landing (V/STOL) Operations, the development of rotorcraft/VTOL systems automated launch and recovery technology and mechanical/environmental failure prediction research. - Examples of research in Propulsion include the Variable Cycle Advanced Technology (VCAT) Program. Major engine manufacturers and system contractors will develop/mature the highest priority, long-lead propulsion system technologies, including variable/adaptive cycle engine components, for next generation carrier-based TACAIR/ISR systems. - Examples of research in Structures and Materials include advanced composite durability technology. - Expanding material degradation risk prediction and operational environment-driven materials selection methods. Pursue research related to Autonomy including efforts on high confidence/Safe Autonomous Control in naval environments and on supervisory control of decentralized heterogeneous UAS. Expand efforts on safe-perception based autonomous control in complex naval environments and on autonomy to support combined unmanned and manned air systems/units. ***FY 2018 OCO Plans:*** N/A					
Title: FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS	2.532	2.527	5.754	0.000	5.754
Description: Fleet Force Protection and Defense against Undersea Threats efforts include applied research for complementary sensor and processing technologies for platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. A goal of this activity is to provide these platforms with effective self-protection.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The technology areas specific to platform protection will develop individual, multispectral electro-optical (EO), infrared (IR), radio frequency (RF), electro-magnetic (EM), visual and acoustic or chemical sensors/ biosensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information. The funding increase from FY2017 to FY2018 is due to the increased investment and research efforts supporting distributed autonomous underwater networks. ***FY 2016 Accomplishments:*** Sensors & Associated Processing: - Continued Electrochemical sensors for the distributed, remote detection of explosives - Continued efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms. - Continued efforts in biomimetic signal processing: panoramic periscope for submarines and temporal pattern recognition for Systems for Security Breaching Noise Detection. - Continued efforts in bioinspired quiet, efficient and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics. - Continued studies to develop catalytic activity profile of bioactive coatings against chemical agents. - Continued design and initiated fabrication of coatings to degrade both, chemical and biological agents. - Continued efforts to design microfabricated system for 3-color fluorescence measurements using integrated waveguides. - Continued effort to develop new, highly selective, preferential oxidation catalysts for the generation of power from the reformate gas purification process. - Continued effort to develop aspheric gradient index optics. - Continued effort to develop an implosion-resistant hydrogen storage technology for use in undersea fuel cells. - Continued development of wide area standoff detection of explosives. ***FY 2017 Plans:*** Sensors & Associated Processing: - Continue all efforts of FY 2016, unless noted as completed above. ***FY 2018 Base Plans:*** Sensors & Associated Processing:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2017, unless noted as completed above. Undersea Warfare -Conduct undersea storage capacity of hydrogen by developing an implosion-resistant, safe, and inexpensive hydrogen storage technology that addresses powering autonomous systems, such as autonomous undersea vehicles and distributed autonomous underwater networks, for persistent force protection and defense against undersea threats. Materials and Chemistry -Design and develop, utilizing room temperature ionic liquids to demonstrate and fabricate inexpensive, miniaturized, low power electrochemical sensors for use in autonomous as well as distributed sensor networks. -Develop real time, standoff, moving target, laser based detection for explosives and hazardous chemicals with the intent of shifting the paradigm of trace chemical detection through surface contact swabbing to a faster, more flexible wide area, standoff method for significant enhancement of force protection. -Develop and design a new class of safe high performance rechargeable zinc air batteries to supplant state of lithium-ion batteries. -Develop chemical vapor sensing strategy for application in marine environment, significantly different than terrestrial environment. -Demonstrate electrochemical detection elements incorporated into electronic integrated circuits. -Demonstrate efficiency of zinc sponge anode in an electrochemical cell. ***FY 2018 OCO Plans:*** N/A					
Title: ADVANCED ENERGETICS ***Description:*** Advanced Energetics efforts address technology development to provide substantial improvements in energetic material systems and subsystems, primarily in terms of performance, but also addressing safety, reliability, and affordability concerns. Goals include: advanced energetic materials for warheads, propellants, and reactive material based subsystems for both defensive and offensive applications. Efforts include: development of new fuels, oxidizers, explosive ingredients and formulations; and reliable simulation tools and diagnostics to develop and design superior-performance, and/or reduced-vulnerability systems tailored to specific warfighter missions. ***FY 2016 Accomplishments:***	5.408	5.339	5.329	0.000	5.329

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued process research and development of Ammonium Nitrotetrazolate-2N-oxide (AONT). - Continued the processing optimization design of material compositions for Reactive Material explosive fragment applications. - Continued optimization and refinement studies of Poly NitratoOxetane (3-PNO) process for solid rocket motor propellants. - Continued the development of a reliable chemical scale-up and material specification process techniques. - Continued ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, letality models, and experiments). - Continued Advanced Energetics research in development and evaluation of advanced explosive/propellant/ reactive ingredients and formulations for the next generation higher performing systems. - Continued non-traditional energy conversion studies with columbic and cluster material investigations. - Continued Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads. - Continued proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. This work involves development of high quality, small particle energetic ingredients, novel processing techniques, and advanced energy conversion concepts; and involves both theoretical and experimental efforts. - Continued Advanced Energetics research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads. - Continued Advanced Energetics research in development and diagnostics of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target for air, surface, and underwater warhead application - Continued research in technology development for the next generation reactive material warhead concepts formulations, material properties, and energy release experiments for highly reactive materials, high density reactive materials and novel reactive structural materials. Transition application specific target interaction, lethality modeling and ordnance specific experiments and demonstrations to Electromagnetic Rail Gun, PE 0603114N. - Continued development and evaluation of energetic ingredients and formulations for next generation higher performance applications. Concluded scale-up development and testing. - Continued the processing optimization design of material compositions for Reactive Material explosive fragment applications. - Continued the development of a reliable chemical scale-up and material specification process techniques. - Continued research on new caged nitramines					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued process research and development of 1,1'-Diamino4,4',5'5'-Tetranitro-2,2'-Biimidiazole (DATNBI) - Continued process research and development of 1-Fluoro-4,5-Dinitroimidazole. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, unless noted as complete above. - Initiate electric on/off propulsion system studies for advanced solid and liquid rocket compositions - Initiate process research and development of Dihydroxylammonium Dinitramino Azoxy Furazan (DDAF) - Initiate process research and development of Ammonium-3,4,5,-trinitropyrazolate (ATNPz) - Complete ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, lethality models, and experiments) - Complete process research and development of 1,1'-Diamino4,4',5'5'-Tetranitro-2,2'-Biimidiazole (DATNBI) - Complete process research and development of 1-Fluoro-4,5-Dinitroimidazole. ***FY 2018 Base Plans:*** - Pursue research related to Advanced Energetics including development and evaluation of advanced explosive/ propellant/reactive ingredients and formulations for the next generation higher performing systems. - Pursue research in proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. This work involves development of high quality, small particle energetic ingredients, novel processing techniques, and advanced energy conversion concepts; and involves both theoretical and experimental efforts. - Expand Advanced Energetics research in development and diagnostics of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target for air, surface, and underwater warhead application. ***FY 2018 OCO Plans:*** N/A					
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E)	74.008	80.882	70.382	0.000	70.382
Description: Technology programs focused on providing technologically superior warfighting capabilities at reduced total ownership costs for surface and subsurface platforms through investments in applied research and advanced technology development of programs in: a) Advanced Naval Power b) hydrodynamics, c) structures d) autonomy for unmanned surface vehicles (USV) and e) platform survivability. This element also includes the National Naval Responsibility in Naval Engineering (NNR-NE). The NNR-NE supports early applied research in the areas of propulsion, platform structures, hydrodynamics, automation control and system engineering,					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
design tools, naval power systems and ensuring a strong and healthy academic infrastructure. Specific research themes are: Advanced Naval Power Systems Technology: Advanced naval power systems efforts address electrical and auxiliary system and component technology to dramatically improve energy and power density, operating efficiency and recoverability from casualties. A major investment focus is providing the power and energy required for directed energy weapons on current and future surface combatants. Advanced Naval Power efforts include: developing technologies for high-power, cyber-secured energy networks, providing warfighting capability with more energy efficient systems; mitigate adverse impacts of alternative fuel on Naval platforms and equipment; and utilizing the Electric Ship Research and Development Consortium (ESRDC) efforts to develop modeling and simulation tools to provide critical design & operational capabilities for the all-electric ship program, accelerate development and demonstration of technologies, reduce risk of new technology insertion and address the national shortage of electrical power engineers. Develop new machinery integration concepts. Develop simulation based Verification, Validation and Accreditation (VV&A) methods and technologies. Contribute to system reconfiguration. Design a ship electrical system architecture based on a main bus that distributes "rough" DC power throughout the ship at nominally 10 KV. Development of macro- and atomic-scale multi-physics models is being pursued to enhance understanding of materials processing & performance, energy conversion mechanisms, cyber-physical energy concepts, and power management. System-level studies focus on the scalability and reliability of component technologies. Another thrust is the development of tools to model heat transfer at multiple length scales allowing for simulation of heat flow through the ship in order to evaluate the impact of power conversion electronics, sensors, and weapons on the overall thermal balance of the vessel. Advanced Sea Platform Performance Technology: Hydrodynamics: Critical platform design for surface ships hydrodynamics that is focused on the theory, computation, and lab and at-sea experimentation to develop understanding and prediction capabilities for all hydrodynamic phenomena associated with surface ships and small craft, their effects on vessel performance, and concepts for modification. Propulsor hydrodynamics is focused on understanding the physics of flow around propulsors and their interactions to improve propulsor performance, mobility, efficiency, and affordability, as well as prediction and control of various types of cavitation on propulsors and appendages. This also includes predictive capability of cavitation inception, thrust breakdown, and erosion phenomenon and scaling					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
laws. Technology efforts in the area of Subsurface Hydrodynamics include identifying, understanding, predicting, and controlling flow physics, as well as turbulence and stratified wakes. This is further applied to Subsurface Maneuvering Technologies, and understanding the Dynamics of Interacting Platforms. Additionally hydrodynamic technologies focused on the signature aspects of the hull-propulsor interaction and maneuvering. Platform Structures: Focused on time-varying, structural reliability analysis and prediction for a ship structural system with uncertainty quantification and propagation. Specific topics include novel structural configurations across composite and metallic materials and prediction methods for advanced global hull strength, local panel and component strength, fatigue and fracture strength, and seaway loads and load effects for high-speed/high-performance ships and vessels. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Unmanned Surface Vehicles (USV): Autonomy for USVs and related mission functions aligned with Naval S&T strategic focus on autonomy and unmanned vehicles. Unmanned Sea Surface Vehicle applied research includes short-term motion forecasting for recovery of USSVs on a host ship in higher sea states and determination of slamming loads on high-speed planing hulls for structural weight reduction Distributed intelligence for automated survivability addresses both the basic technology of automating machinery control systems, as well as, distributed control of systems utilizing autonomy for mission context based reconfiguration. Sea Platform Survivability Technology: Aligned with survivability S&T strategic focus area, research investigates electromagnetic (EM) sources (including major ferro and non-ferromagnetic sources, eddy currents, and Corrosion Related Magnetic Fields (CRM)) that are associated with naval platforms. Develop understanding of EM field propagation relationships and analysis aids, and technologies to predict the electromagnetic properties of a naval platform. Advance physics based understanding of platform acoustics. Discover and develop algorithms and methods that will enable the development of improved design, analysis, and prediction tools for enhanced acoustic performance. Understand, design and develop optical and acoustic metamaterials to control light and sound propagation over a large frequency range. New architectures to overcome challenges associated with loss, bandwidth, and scalability are being explored. Design and develop models, algorithms, and integrated development environments for simulation and control of complex, interdependent, distributed shipboard machinery systems to enable integrated, autonomous operation and reconfiguration of shipboard machinery systems. Efforts also					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability (includes damage control), and advanced naval power systems. Signature reduction addresses electromagnetic, infrared, and acoustic signature tailoring, both topside and underwater. The funding increase from FY 2016 to FY 2017 is due to the ramping up of the Medium Displacement Unmanned Surface Vehicle (MDUSV) program and the Applied Research Challenge (ARC) effort. The funding decrease from FY 2017 to FY 2018 is due to the realignment of the Medium Displacement Unmanned Surface Vehicle (MDUSV) Leap Ahead effort to a new PE 0602792N Innovative Naval Prototypes (INP) Applied Research for consolidation of the Leap Ahead/INP portfolio. ***FY 2016 Accomplishments:*** Survivable Platforms - Reduced Signatures: - Continued advanced numerical acoustic codes (and gridding methods for those codes) for submarines. - Continued Alternating Current (AC) propagation experiments. - Continued the next generation Infrared Electro-Optic Visual (IR/EO/VIS) model for surface ships by development of mitigation strategy supporting low observable infrared platforms, development of supporting physics, and prototype measurement techniques. - Continued development of quiet control surface design tool based on control surface flow noise studies. - Continued IR and radar detectability prediction capability. - Continued surface ship super-conductive degaussing with laboratory demonstration loop for Electromagnetic (EM) field accuracy measurements and control methods. - Continued testing on Advanced Electric Ship Demonstrator (AESD) to assess energy propagation and acoustic radiation mechanisms and to develop mitigation concepts for surface ships. - Continued Improved Corrosion Related Magnetic (CRM) Field Prediction Model to design compensation systems to reduce ship's CRM signature. - Continued assessment of ship bi-static Radar Cross Section (RCS). - Continued large-scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion. - Continued experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of modeling methods and noise control concepts for modular/reconfigurable submarine architectures. - Continued investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Continued development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Continued development of Low Probability Intercept (LPI) technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems. - Continued advanced EM modeling tools development and validation. - Continued modeling of hydroacoustics of turbulence-propulsor interaction. - Continued joint effort with UK/MoD on adhesively joined aluminum in lieu of welding of marine structures and thus reduce cost. - Continued joint effort with the Netherland Royal Navy (NLRN) on adhesive joined composite to metals in lieu of bolting of marine structures and thus reduce cost for topside structures. - Continued efforts on shock mitigation and shock diversion for ship hulls to reduce cost of machinery mounts and equipment, based on successful results from the Explosion Resistant Coatings (ERC) helmets for protection against Traumatic Brain Injury (TBI) - Continued utilization of condition-based maintenance systems for platform underwater signature assessment. - Continued development of signature monitoring and management capability of a surface ship propulsion system for underwater acoustic signatures. - Continued development of global optimization of damped structures. - Continued development of non-intrusive sensing method to measure component acoustic signatures. - Continued to develop improved processing techniques for acoustics experiments. - Continued development of a prediction and monitoring tool for underwater signatures. - Initiated planning at-sea experiments to determine principal offenders for small craft airborne and underwater acoustic signatures. - Initiated development of high fidelity airborne acoustic propagation and detection model for surfzone and littoral detection of small craft. - Initiated development of radar absorbing ballistic composite materials for small craft hull and superstructures. Survivable Platforms - Hull Life Assurance: - Continued efforts on combinations of highly rate-sensitive materials through experiment and modeling for extreme hyper velocity threat conditions. - Continued development of global surface wave measurement capability for ship models.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued Dynamic Behavior of Composite Ship Structures (DYCOSS) (joint effort with Dutch Navy). - Continued development of structural analysis codes describing failure mechanism of sandwich composites. - Continued Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia. - Continued composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures. - Continued effort on an advanced class of polymers as a follow-on to current ERC for application against advanced threats. - Continued Payload Implosion and Platform Damage Avoidance efforts. - Continued development of advanced analytical, numerical and experimental methods in support of platform signature reduction. - Continued effort on exploitation of polymers for the deflection and dissipation of shock wave impact on ship and submarine hull structures. - Continued development of lightweight low-cost protection system for specific platforms for protection against specific large threats. - Continued development of lightweight protection system for vehicles (MTVR) for protection against specific small arms and IEDs for the Explosion Resistant Coatings (ERC) program. - Continued Ship modifications using blisters for application to DDG51 Flight III to gain larger displacement for AMDR and at the same time achieve higher fuel efficiency. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continued development of modeling and simulation methods for robust design and virtual testing of integration of shipboard auxiliary systems including their control systems. - Continued research into advanced HM&E system reconfiguration approaches, including agent-based control systems and algorithms, and model-based reasoning. - Continued demonstration of Genetic Algorithm(s) for determining optimal distributed system control strategy. - Continued development of Survivability Analysis Algorithms Operable on a Total Ship Modeling Environment. - Continued the transition of the small scale hardware-in-the-loop demonstrator to the academic community for challenge problem formulation. - Continued demonstration of the developed model based reasoning control algorithms on full scale hardware test beds. - Continued development of underwater signature modeling.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Advanced Platforms - Advanced Platform Concepts and Designs: - Continued validation of asymmetric hull forms with experimental data. - Continued development of analytical models to further define submarine modular hull concepts. - Continued development of reliability based design and structural analysis code development. - Continued development of design tools for integrated antenna and composite topside. - Continued circulation control analysis for three-dimensional flow effects. - Continued aperstructures microwave communication system. - Continued concept for Ultra High Frequency (UHF)/Very High Frequency (VHF) aperstructures opportunistic array (Advanced Hull-form Inshore Demonstrator - AHFID). - Continued development of methods for determining reliability and vulnerability of aluminum ship structures. - Continued large scale demonstration efforts of advanced mitigation technologies. - Initiated activities in understanding platform modification for greater access in polar environments. Advanced Platforms - Hydromechanics: - Continued experimental database/computational tools development for extreme submarine maneuvers (e.g., crashback). - Continued the validation of circulation control and advanced control surfaces with experiments. - Continued to investigate improved maneuvering simulation capability for submarines. - Continued numerical prediction method(s) of waterjet cavitation. - Continued modeling and simulation of rough-wall boundary layer noise. - Continued development of podded propulsor design/analysis tools. - Continued prediction and validation of damaged stability and capsize. - Continued non-body-of-revolution tool development for advanced submarine configurations. - Continued the multi-platform interaction analysis and tool development. - Continued modeling of performance of composite propellers in extreme maneuvers. - Continued cavitation erosion modeling on compliant surface. - Continued a research on design/analysis methods of ice-capable propellers. - Continued a research on the effect of propeller on bubbly flows. - Initiate efforts to model platform performance and stability as well as propulsor performance in ice environments. Advanced Naval Power Systems:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued demonstration of dynamic stability of an advanced intelligent, reconfigurable, solid-state-based, zonai-electrical-power system that reconfigures within 10 milliseconds. - Continued designing software for the system manager for the Universal Control Architecture (UCA). - Continued development of thermal management technology for shipboard power distribution. - Continued investigation of potential applications of silicon-carbide in future high voltage and high power applications. - Continued improvements in electrical component and device technology allowing a reduction in motor propulsion and motor controllers weight and volume. - Continued development of technologies to support dynamic reconfiguration of shipboard systems under conditions of stressing scenarios and/or system degradation. - Continued studies of alternative cooling systems for future shipboard radar systems. - Continued control surface actuator project focused on the technologies needed to define the design space for control surface actuators supporting submarines. - Continued development of automated HVAC system architectures for future Naval platforms. - Continued ship service fuel cell development. - Continued program to develop and demonstrate 3 - 50 kW class solid oxide fuel cell onboard mobile power generation capabilities having compatibility with future logistics fuels to enable rapid recharge of batteries and direct power for C4ISR equipment. - Continued analytical model and reduced scale component development of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers focusing on closing technology gaps associated with Alternative Integrated Power System (IPS) Architectures. - Continued studies of advanced heating, ventilation, and air-conditioning architectures, including studies of alternative (nonvapor-compression) refrigeration systems and concepts for waste heat reuse, to enhance ship cooling and provide thermal energy storage. - Continued research into the development of fuel chemistries, materials, and energy conversion technologies for optimal performance in Naval power systems. - Continued development of robotic Hull BUG and coating technologies to reduce hull biofouling over current Navy operating conditions which will reduce drag and provide significant power/fuel/cost savings. - Continued development of fuel cell components needed to make robust, compact, lightweight fuel cell systems for use in unmanned vehicles. - Continued development of low cost, light weight, flexible solar cells.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued effort to make significant impact in high voltage power electronics technology to enable compact power converters, medium voltage distributed power architectures, new weapons and sensor systems for Navy and Marine applications. - Completed effort to integrate front- and back-side diamond with high current GaN power switches for advanced thermal management. - Completed SiC GTO thyristor designs and testing apparatus to increase the turn-on dI/dt and reliability of SiC GTOs for pulsed power. Surface Ship & Submarine HM&E Applied Research: - Continued efforts to implement the results from hybrid composite blisters /appendages and their effect on ship drag resistance and fuel saving performance, motion and stability in ship models to verify computations and adapt shapes of appendages. - Continued to increase emphasis of the Science Advisor engagement within the joint S&T community across DOD, which will focus on addressing the operational and strategic needs of the Fleet. - Continued applied research into short-term motion forecasting for recovery in higher sea states. - Continued applied research into determination of slamming loads on high-speed planing hulls for structural weight reduction. - Continued the ONR Applied Research Challenge (ARC) to stimulate new, high-risk applied research projects in areas not currently addressed by the current ONR core applied research programs. - Initiated Medium Displacement Unmanned Surface Vessel (MDUSV) program applied research supporting a highly autonomous control and payloads supporting mine warfare, anti-submarine warfare and electronic warfare. Advanced ASW Surveillance: - Continued development of Long Endurance UUV technologies. Counter Improvised Explosive Devices: - Continued efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs. - Continued research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks) - Continued research in directed energy weapons with the goal of reducing size, weight, and power requirements for systems in the detection and neutralization of IEDs.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research in the mitigation of CIED effects (blast, blunt trauma, ballistics) on personnel. - Continued research in Route Reconnaissance and Clearance methodologies to provide standoff detection, neutralization, and marking of buried and surface laid, on and off route, pressure plate, command wire and radio frequency initiated explosive obstacles using directed energy and mechanical means on autonomous or semi autonomous platforms Applied Research Challenge (ARC): - Continue all base program efforts initiated in FY 2015 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support / uncertainty analysis for operational environments, and reactive composite materials. Signature reduction: - Continued study of graphene based magnetic tunnel junctions.					
FY 2017 Plans: Survivable Platforms - Reduced Signatures: - Continue all efforts of FY 2016, unless noted as completed above. - Complete large scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion - Complete investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Complete development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Complete utilization of condition-based maintenance systems for platform underwater signature assessment. - Complete development of non-intrusive sensing method to measure component acoustic signatures. Survivable Platforms - Hull Life Assurance: - Continue all efforts of FY 2016, unless noted as completed above. - Complete Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia - Complete composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures. - Initiate Explosion Resistant Coatings (ERC) effort with TTCP countries.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate development of testing methodologies to validate computational codes and constitutive models for glassy materials. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continue all efforts of FY 2016, unless noted as completed above. Advanced Platforms - Advanced Platform Concepts and Designs: - Continue all efforts of FY 2016, unless noted as completed above. - Initiate activities in understanding platform modification for greater access in polar environments. Advanced Platforms - Hydromechanics: - Continue all efforts of FY 2016, unless noted as completed above. - Initiate efforts to model platform performance and stability as well as propulsor performance in ice environments. Advanced Naval Power Systems: - Continue all efforts of FY 2016, unless noted as completed above. - Complete development of robotic Hull BUG and coating technologies to reduce hull biofouling over current Navy operating conditions which will reduce drag and provide significant power/fuel/cost savings. Surface Ship & Submarine HM&E Applied Research: - Continue all efforts of FY 2016, unless noted as completed above. Counter Improvised Explosive Devices: - Continue all efforts of FY 2016, unless noted as completed above. - Complete efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs. - Complete research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks) - Initiate research and development of modular, reconfigurable, integrated multi-modal stand-off detection and neutralization of explosive hazard (IED & Mines) system. Applied Research Challenge (ARC):					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all base program efforts initiated in FY 2016 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support/uncertainty analysis for operational environments, and reactive composite materials.					
FY 2018 Base Plans: Advanced Naval Power Systems Technology: Pursue research related to the Next Generation Integrated Power System (NGIPS) and Distribution/Control of Power Advanced Power Systems with a focus on power and energy requirements for directed energy weapons on current and future surface combatants. Conduct applied research related to critical S&T to investigate efforts related to Power & Energy Technology, including alternative power sources, UAV fuel cell development and power and energy outreach and sustainability efforts Advanced Sea Platform Performance Technology: Conduct applied research related to critical S&T to investigate platform design efforts related to propulsor and subsurface hydrodynamics; structural reliability science; and structural acoustics. (FGLI 2018-0358) Expand research related to the unmanned sea surface vehicle and Medium Displacement Unmanned Surface Vehicle (MDUSV) efforts. Pursue research related to naval engineering and platform design, including Ohio Replacement Program efforts. Sea Platform Survivability Technology: Conduct applied research related to critical S&T to investigate efforts related to signature reduction; machinery autonomy; and platform survivability. Science & Technology to Address Complex Hybrid WarfareThreats: - Continue all efforts of FY 2017, unless noted as completed above. - Complete research in the mitigation of C-IED effects (blast, blunt trauma, ballistics) on personnel. - Initiate projects to counter complex hybrid warfare threats. S&T technologies will address a broad range of multi-faceted threats that employ both conventional and unconventional forces. Applied Research Challenge (ARC):					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all base program efforts initiated in FY 2017 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support/uncertainty analysis for operational environments, and reactive composite materials. Materials and Chemistry (NRL) Understanding methods for fabricating nickel / graphene / cobalt magnetic tunneling junctions to develop new tunnel barrier materials technology for fast low power radiation hard memory and magnetic sensors. This effort will be a paradigm shift for magnetic tunnel junction technology, which is significantly different than use of conventional oxides such as MgO and Al2O3. Successful accomplishments have been made to show that graphene can be used as a tunnel barrier material. Electronics (NRL) Create and explore new high voltage, high efficiency wide bandgap and ultra-wide bandgap power switches for electric propulsion and electric weapons. ***FY 2018 OCO Plans:*** N/A					
Title: NAVAL RESEARCH ENTERPRISE ***Description:*** The Independent Applied Research (IAR) R2 activity was stood up in FY 2013 as the Naval Research Enterprise (NRE) to consolidate all NRE related IAR investments. Projects funded in this R2 Activity are intended to be approximately 2-3 years in length. Based on historical trends approximately 30% of these projects will turn over each year. The Naval Research Enterprise (NRE) encompasses the IAR efforts focused on solving a wide range of Naval Science and Technology (S&T) fleet issues utilizing unique Naval Warfare Center (WC) laboratory capabilities. Efforts under this activity address the full spectrum of the DON S&T Strategic Plan technology using focus areas which engage Naval aviation, sea surface, undersea, space, weapons, communication, information, and human systems. The IAR Program provides participating WCs with in-house funding for applied research to support the execution of their assigned missions by: -Developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems. -Promoting the hiring and development of talented new scientists and engineers (S&E) with the insurance of proper mentoring with senior personnel.	4.551	4.545	4.631	0.000	4.631

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Encouraging collaboration with universities, private industry, and other Navy and Department of Defense laboratories. Funded projects are chosen through rigorous internal competition by each WC's selection committee and typically last two to three years. IAR projects are generally designed to promote investment in high-risk/high-payoff research and also allow young S&Es to manage Navy relevant research projects. A limited number of successful efforts developed under the In-House Laboratory Independent Research (ILIR) basic research Program Element 0601152N are matured and further developed under the IAR program with the goal of transitioning these technologies to the warfighter. ***FY 2016 Accomplishments:*** - Continued research for the repair and repair process of Navy aircraft and ship alloys such as titanium and high-strength low-alloy steels, composites, and metamaterials. - Continued research for highly accurate autonomous unmanned undersea vehicles (UUV) communication and navigation. - Complete all two year efforts started in FY 2015 and three year efforts started in FY 2014. Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE: - Completed research on Bio-inspired Broadband Sonar System for High-resolution Acoustic Imaging Applications. - Completed research on Advanced Infrared Suppressor. - Completed Determining R-45M Prepolymer Characteristics that Optimize Propellant Cure and Mechanical Properties. - Completed Development of Novel Propellants and Explosives Using Resonant Acoustic Mixing (RAM) Technology. - Completed study of the Electromagnetic Probability-of-effect Assessment Tool (EMPAT) for High-Power HERO/EMV Test and Evaluation . - Completed Examination of Human Performance Characteristics using Eye-tracking and 3D Motion Capture Gaze Supported Gestures. - Completed research on Extended Object Tracking in Clutter with Exploitation of Doppler Measurements and Multi-Scan Detection Clustering. - Completed Research on Geospatial and Temporal Anomaly Detection using Scalable Cloud-Based Algorithms - Completed Improving Damage Tolerance Thresholds and Energy Absorption Capacities in Laminated Woven Composites using Crimp Imbalance and Crimp Imbalance Gradients					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed Nondestructive Evaluation (NDE) Enhanced Accelerated Life Testing (ALT). - Completed Synthesis and Characterization of Novel Reactive Materials by Mechanical Alloying. - Completed Smoothed Particle Applied Mechanics research. - Initiated FY 2016 projects. ***FY 2017 Plans:*** - Complete FY 2015 IAR projects which were three years in duration. - Continue IAR projects initiated in FY 2016. - Initiate FY 2017 IAR projects that are intended to be approximately three years in length. ***FY 2018 Base Plans:*** - Complete FY 2016 IAR projects which were three years in duration. - Continue IAR projects initiated in FY 2017. - Initiate FY 2018 IAR projects that are intended to be approximately three years in length. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	155.137	158.745	125.557	0.000	125.557

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. Each PE Activity has unique goals and metrics, some of which include classified quantitative measurements. Overall metric goals are focused on achieving sufficient improvement in component or system capability such that the 6.2 applied research projects meet the need of or produce a demand for inclusion in advanced technology that may lead to incorporation into acquisition programs or industry products available to acquisition programs. Efforts funded in this PE also include energy programs in support of SECNAV energy goals and efforts in support of the Ohio Replacement program.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602123N / *Force Protection Applied Res*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	19.310	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.310

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Alternative Energy Research	19.310	0.000
FY 2016 Accomplishments: - Continue microgrid analyses at Naval Facilities in Hawaii to increase energy security for critical infrastructure and to determine capabilities needed for effective base-to-utility interconnect under conditions of high-penetration of renewables. - Continue heat exchanger material corrosion evaluation and process control evaluations for Ocean Thermal Energy Conversion (OTEC) systems. - Continue development of sophisticated hydrodynamic tools for design of high performance, high efficiency hull forms for naval ships and craft. - Continue support for wave energy system environmental characterization and modeling. - Continue hydrogen fuel cells research for operations in harsh environments including unmanned vehicles. - Continue support for energy storage technologies to mitigate the impact of renewables on grid stability. - Complete evaluation of grid frequency control techniques using grid frequency response and battery state-of-charge algorithms for lithium-titanate battery system, demonstrating 40% reduction in frequency variability on grid with high-penetration of wind power, and initiated similar battery approaches at grid locations with high-penetration of photovoltaics.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	19.310	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 9999 / *Congressional Adds*

E. Performance Metrics

Congressional Interest Items not included in other Projects.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602131M *I Marine Corps Lndg Force Tech*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	50.164	51.590	53.936	-	53.936	60.036	57.036	51.036	52.057	Continuing	Continuing
3001: *Marine Corps Landing Force Tech*	0.000	44.371	51.590	53.936	-	53.936	60.036	57.036	51.036	52.057	Continuing	Continuing
9999: *Congressional Adds*	0.000	5.793	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.793

A. Mission Description and Budget Item Justification

The efforts described in this Program Element(PE)are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps) to include specific Marine Corps objectives defined by the USMC S&T Strategic Plan. It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. Expeditionary Force 21 (EF 21) is the Marine Corps' foundational Capstone Operating Concept that provides vision and context for developing future operating and functional concepts that in turn guide capability development and this PE. Using future concepts, science and technology (S&T) performers can focus less technologically mature applied research in areas where end state capabilities are not fully defined and on S&T opportunities where feasibility is not fully developed or known but is also potentially game changing. EF 21 aligns with national level strategic guidance including the National Security Strategy (NSS), National Military Strategy (NMS), Defense Strategic Guidance (DSG), Quadrennial Defense Review (QDR) and with Naval strategy in the Department of the Navy's Cooperative Strategy for 21st Century Seapower.

Expeditionary Force 21 describes a future Marine Corps ground force that will have cornerstone characteristics of being naval, expeditionary, agile, and lethal. This force will face security environments and threats driven by Complex Terrain (to include informational and human aspects), Technology Proliferation (including precision weapons), Information used as a Weapon, Battles of Electromagnetic (EM) Spectrum Signatures, and Increasingly Contested Maritime Domains. The future Marine Corps will be designed to meet those future security environments but needed force characteristics also impose constraints and challenges on future operating concepts and capabilities. EF 21 provides the context in which promising and innovative applied research is explored to determine scientific feasibility of potential solutions and opportunities to enhance, change, or invent future concepts with S&T. For example within the above naval force characteristics, amphibious operations against EM signature aware threats with advanced weapons systems will be part of future Marine operating concepts. Promising science opportunities in autonomy may enable new concepts and capabilities in agility, lethality, and signature management that have not even been defined. The EF 21 context brings constraints and challenges that stimulate unique science and technology (S&T) requirements and opportunities that define this PE.

S&T projects in this PE explore the feasibility of applied research to meet broad Marine Corps conceptual requirements within the unique constraints described above in the warfighting functional areas of: Command, Control, Communications, Computers (C4); Intelligence, Surveillance, and Reconnaissance (ISR); maneuver and mobility; force protection; logistics and sustainment; human performance, training and education, firepower, and Expeditionary Cyber. This PE funds applied research, future

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602131M *I Marine Corps Lndg Force Tech*

technology assessment and road mapping, future technology concepts, and less technologically mature projects within the Future Naval Capability (FNC) process as means to inform, enhance, and invent future concepts and capabilities with new S&T.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	51.643	51.590	53.936	-	53.936
Current President's Budget	50.164	51.590	53.936	-	53.936
Total Adjustments	-1.479	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.479	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Cyber Research*	5.793	0.000
Congressional Add Subtotals for Project: 9999	5.793	0.000
Congressional Add Totals for all Projects	5.793	0.000

Change Summary Explanation

Technical: Not Applicable.

Schedule: Not Applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602131M / *Marine Corps Lndg Force Tech*	Project (Number/Name) 3001 / *Marine Corps Landing Force Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
3001: *Marine Corps Landing Force Tech*	0.000	44.371	51.590	53.936	-	53.936	60.036	57.036	51.036	52.057	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project is organized into ten activities, which are represented as eight Expeditionary Warfighting Capability Areas, as well as Future Concepts, Technology Assessment & Roadmapping, and the USMC Future Naval Capabilities(FNCs) Program. The eight Expeditionary Warfighting Areas support the Discovery and Invention (D&I) portfolio investment. The USMC FNCs support the Technology Maturation/Acquisition Enabler investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4)	4.180	4.730	4.419	0.000	4.419

Description: This activity supports S&T investment in Command and Control and is focused in three main areas: (1) Implementing the FORCEnet concept (2) Developing decision support systems that enable warfighters to take advantage of the FORCEnet and MAGTF C2, and tactically extend Net-Enabled Command and Control (NECC) for shared situational awareness; and (3) Providing effective combat identification of enemy combatants, friendly forces, and non-combatants. FORCEnet is the operational construct and architectural framework for naval warfare in the information age that integrates warriors, networks, command and control, and weapons into a networked, distributed, combat force that is scalable across all levels of conflict from the seabed to space, and from sea to land. The Marine Corps instantiation of FORCEnet is Marine Air Ground Task Force Command and Control (MAGTF C2), with technologies to exchange data and information with, and among, distributed tactical forces. Activities in this program area provide technologies for secure, robust, self-forming, mobile communications networks and distributed computing to support information dissemination to all echelons; and sensors, software and data processing to support formation of an appropriate common picture. Marine Corps specific efforts include power management, low detectability, size and weight constraints, and interoperability within the joint environment.

FY 2016 Accomplishments:
- Continued development of urban/restricted environment communications technologies.
- Continued Adaptable Antennas, Self-Adapting Radio Prototype and RF Technologies efforts.
- Continued Cognitive Networking and Trusted Computing Technology efforts.
- Continued an Electro-Magnetic Technologies effort.
- Continued a meta-material antennas effort.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed a limited distributed, Cyber Technology development effort. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. - Complete a meta-material antennas effort. - Complete an Electro-Magnetic Technologies effort. - Initiate Advanced Expeditionary Cyber Technology efforts. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete Cognitive Networking and Trusted Computing Technology efforts. - Initiate Photonic Component Technologies - Initiate Full Duplex Technologies - Transfer all USMC 6.2 Cyber Technology to Expeditionary Cyber Activity. ***FY 2018 OCO Plans:*** N/A					
Title: FIREPOWER ***Description:*** This activity develops technology for application on current and future expeditionary weapons and elements of the kill chain. It includes, but is not limited to, the following technologies: Fuze, fire control, launch/ propulsion, lethality, and accuracy. The FY2016 to FY2017 increase in the Firepower Activity is for the increased efforts in High Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) to include projectile integration, lethality enhancement, fuze setting integration and aerodynamic and aerospace technologies. ***FY 2016 Accomplishments:*** - Continued investigation of the scalability of variable effects conventional munitions and gun technology for improving firepower effectiveness while increasing affordability and decreasing logistics burden in support of expeditionary warfare. - Continued development of precision fires engagement technologies, to include trajectory shaped 81mm mortars, 83mm missiles, and smaller precision munitions. - Continued design and development of lightweight technologies to provide individual Marines enhanced capabilities to detect and identify man-sized targets to the maximum effective ranges of their individual weapons,	4.854	6.550	6.131	0.000	6.131

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
during all conditions (daylight, limited visibility, & darkness), by integrating multiple optics capabilities into a single system. - Continued Semi-Autonomous Fires Technology. - Continued Awareness for Lightweight Engagements and Remote Targeting (ALERT) to develop large aperture, lightweight lens with enhanced fields of view. - Continued Azimuth and Inertial Micro-electromechanical System (MEMS) Navigation System (AIM) to develop low cost, precision, inertial navigation systems for use in highly accurate handheld targeting systems, shoulder launched missiles, and munitions. - Continued Caseless, Lightweight, Low-volume Round (CLLVR) to develop lightweight, small caliber ammunition for individual, crew served, and remotely mounted weapons. - Completed Disruptive Energetic Materials (DEM) to exploit nano-energetics developments for significant enhancement of explosive yield per warhead mass and volume. - Completed the development of a concept for an insensitive munitions propulsion system to enable firing a shoulder launched rocket from an enclosed space. This program will transition to the Future Naval Capabilities program. - Initiated High-Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) to develop high-reliability sub-munitions fuzing technologies.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete Azimuth and Inertial Micro-electromechanical System (MEMS) Navigation System (AIM) to develop low cost, precision, inertial navigation systems for use in highly accurate handheld targeting systems, shoulder launched missiles, and munitions. - Initiate development of concept for thin film materials to thermally mask equipment and munitions and provide counter rocket, artillery, and mortars (C-RAM) capability for future munitions. - Initiate development of concepts for a 155mm mortar or self-propelled Howitzer that would utilize existing stockpiles of 155mm artillery ammunition.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete development of concepts for a 155mm mortar or self-propelled Howitzer that would utilize existing stockpiles of 155mm artillery ammunition.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Caseless, Lightweight, Low-volume Round (CLLVR) to develop lightweight, small caliber ammunition for individual, crew served, and remotely mounted weapons. ***FY 2018 OCO Plans:*** N/A					
Title: FORCE PROTECTION ***Description:*** This activity supports the Force Protection Thrust's applied research program. Technologies are being developed that focus on the following: Explosive Hazard avoidance, detection, breaching/neutralization, marking and analysis; Air Defense/Counter Rocket, Artillery, and Mortars; Counter tactical surveillance and targeting, and technologies for improved protection for individuals including Marine Personnel Protective Equipment against blast, ballistic and blunt impact threats. ***FY 2016 Accomplishments:*** - Continued development of technologies for stand-off detection and neutralization of mines, IEDs, and Unexploded Ordnance (UXO). - Continued development of technologies to defeat side/top attack and advanced mine fuzes (seismic, acoustic, and infrared) through advanced signature reduction, duplication, and projection. - Continued technology development programs to address force protection personal protective equipment capability gaps. - Continued Counter Rockets, Artillery, Mortars, and Sniper efforts addressing indications and warnings for pre-shot sniper detection and enabling detection of sniper observation and targeting in advance of a ballistic event. - Continued the development of technologies that will detect and classify optics (sniper scopes, ccds, eyeball, etc) from a moving platform due to an urgent operational need. - Continued a program to determine the feasibility to detect and neutralize anti-helicopter mine threat. - Continued the refinement and improve current suite of advanced biomechanical instrumentation to assess potential reductions of Warfighter mobility and functionality caused by PPE systems. - Continued the scientific investigation into an integrated PPE performance tool for assessing coordinated human and armor performance (mobility, back-face deformation, area of coverage, propensity for injury and mass). - Continued broad based material (ceramics, fiber and fiber re-enforced plastics) studies so that significant weight reductions (greater than 50%) can be achieved. - Continued studies to improve ballistic and blast armor material and systems models so that novel concepts can be evaluated and material property characteristics which provide the necessary improvements can be identified prior to significant monetary investments.	5.376	6.090	6.679	0.000	6.679

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued modeling and simulation efforts for the Warfighter-as-a-System analysis approach and methodology combining survivability, mobility, and warfighter performance parameters. - Continued a program to develop modular mission packages for the detection, neutralization, marking and reporting of explosive hazards using multiple, existing vehicles in movement to contact and amphibious raid scenarios. - Continued a program to study the use of autonomous vehicles in the detection, neutralization, marking and reporting of explosive hazards using multiple, existing vehicles in movement to contact and amphibious raid scenarios. - Completed a program to study the fundamental sciences of homemade explosives due to urgent operational needs.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete Counter Rockets, Artillery, Mortars, and Sniper efforts addressing indications and warnings for pre-shot sniper detection and enabling detection of sniper observation and targeting in advance of a ballistic event. - Complete the development of technologies that will detect and classify optics (sniper scopes, ccds, eyeball, etc.) from a moving platform. - Complete the scientific investigation into an integrated PPE performance tool for assessing coordinated human and armor performance (mobility, back-face deformation, area of coverage, propensity for injury and mass). - Initiate the study of technologies to enable detection of explosive hazards and surveillance/targeting systems in complex environments such as jungles and the littoral environment.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete technology development programs to address force protection personal protective equipment capability gaps (Transitioned from Maneuver activity). - Complete the refinement and improve current suite of advanced biomechanical instrumentation to assess potential reductions of Warfighter mobility and functionality caused by PPE systems. - Complete modeling and simulation efforts for the Warfighter-as-a-System analysis approach and methodology combining survivability, mobility, and warfighter performance parameters. - Complete the study of technologies to enable detection of explosive hazards and surveillance/targeting systems in complex environments such as jungles and the littoral environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
-Initiate projects that enable detection of explosive hazards and surveillance/targeting systems in challenging operational environments based on previous study. ***FY 2018 OCO Plans:*** N/A					
Title: HUMAN PERFORMANCE, TRAINING AND EDUCATION	4.904	4.920	3.153	0.000	3.153
Description: This activity addresses the applied research effort of the USMC Human Performance Training and Education area (HPT&E). The HPT&E thrust investment profile is directed at two technology investment areas, Warrior Resilience, and Decision Making and Expertise Development. The funding aligned to Warrior Resilience is focused on advanced training technologies and methodologies that enhance neural, cognitive, and physical readiness. Those funds aligned to Decision Making and Expertise Development refers to training and education technologies and methodologies that accelerate the development and improve the retention of skills in decision making, situation awareness, and individual and team adaptability and coordination on decentralized, dynamic and dispersed battlefields. The FY2017 to FY2018 decrease in the Human Performance Training and Education (HPT&E) activity is due to completion of all Small Unit Decision Making (SUDM) efforts. ***FY 2016 Accomplishments:*** - Continued studies into next generation physical performance enhancement methodologies and technologies (enhanced warfighter psycho-physical performance). - Continued research to evaluate the feasibility of integrating augmented reality technologies into current and emerging training systems. - Continued the development of foundational learning theories extended to complex tasks for a range of expertise levels, training mitigation strategies triggered by neurophysiological markers of learning, cognition and expertise, and principles of expertise development on a continuum of novice to expert. - Continued research into the effects of glucose administration to mitigate stress reactions in trauma patients. - Continued design and development of an automated functional movement screening system to provide a low cost accurate solution for fit-for-duty evaluations and injury prevention training. - Continued development of statistical methods for measuring small unit decision making (SUDM), using previous work on developing assessments of small unit decision making (e.g., Levels of Mastery), and provide a series of training sessions on statistical modeling to enable ground work to be laid by SUDM projects to also use statistical modeling.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated research into automated simulation content generation via a field worn sensor suite. - Initiated research for establishing optimal training intervals for improvement in physical performance and warrior mindset. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. - Complete the development of foundational learning theories extended to complex tasks for a range of expertise levels, training mitigation strategies triggered by neurophysiological markers of learning, cognition and expertise, and principles of expertise development on a continuum of novice to expert. - Complete development of statistical methods for measuring small unit decision making (SUDM), using previous work on developing assessments of small unit decision making (e.g., Levels of Mastery), and provide a series of training sessions on statistical modeling to enable ground work to be laid by SUDM projects to also use statistical modeling. - Initiate the use of augmented reality technologies into tactical decision making tools to support information dominance requirements. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete research into the effects of glucose administration to mitigate stress reactions in trauma patients. - Complete design and development of an automated functional movement screening system to provide a low cost accurate solution for fit-for-duty evaluations and injury prevention training. - Initiate research into developing artificial intelligence to support infantry simulation based training. ***FY 2018 OCO Plans:*** N/A					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) ***Description:*** This activity develops ISR technologies for applications in future intelligence, surveillance, and reconnaissance. Technologies being pursued enhance situational awareness, persistent surveillance, and tactical decision making through automated analysis of data and rapid integration of information and acquired knowledge. Specific technologies in this activity effectively present actionable information to decision-makers, especially those at the lower command levels. This includes biometrics for expeditionary operations, complete future automation of options and persistent surveillance in support of distributed operations.	2.794	3.160	6.953	0.000	6.953

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The FY2017 to FY2018 increase in the Intelligence, Surveillance and Reconnaissance activity is due to strong demand signals from the Marine Corps to address Tactical Cloud Computing Challenges. Effort has focused work on two fronts: connecting tactical clouds to each other and connecting tactical clouds to traditional Marine Corps Tactical Service Oriented Architecture in a contested operational environment. ***FY 2016 Accomplishments:*** - Continued development of low power consumption urban sensing technologies. - Continued development of information on demand technologies to provide the warfighter with the right information at the right time. - Continued development of urban sensing technologies to detect weapons at distance. - Continued development of advanced tactical sensor technologies to improve unit awareness. - Continued development of distributed information architecture technologies. - Continued Actionable Intelligence for Expeditionary and Irregular Warfare effort which includes real-time methods for Identifying Human Networks. - Continued efforts addressing "battlespace awareness" of human networks, improving the accuracy of classification decisions and enabling a human network predictive capability. Once a human network sensor can be defined and dynamically observed in a common feature space, predictive capabilities are realized. If one network is observed to be moving towards at risk behavior, a generalized force warning may be enabled addressing the threat associated with all networks with similar human network sensors. When combined, research into human network awareness, network classification and network prediction, will be a powerful tool for warfare against the irregular actor. - Continued development of adaptable enemy course of action engine to manipulate adversary decisions. - Continued efforts to track entities of interest in a high clutter environment via geolocation of optical tags from a UAV platform. - Continued development of capabilities to integrate socio-cultural models of human behavior with the ability to forecast the processes of decision making through predictive forecasting models. - Continued efforts to derive high resolution models of human networks statistically, with associated behavior attributes. - Continued research on the automated deconfliction and fusion of multi-intelligence tracks on movers of interest, enabled by a rich maritime ontology and active wiki technology. - Continued work on specific nanomaterial triggers and receptors. - Continued work on new optical taggants with improved producibility.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research in automated techniques to establish the reliability of data from human and machine sources. - Continued technology development efforts required to enable a lightweight hyperspectral sensor capable of material characterization. - Continued research to develop algorithms that can disambiguate complex network graphs containing millions of sparsely characterized nodes. - Continued development of advanced analytics (data disambiguation, conditioning, fusion and dissemination) as a set of map reduce tasks that can run across a highly distributed data architecture. - Continued research in deep machine understanding of information requirements relevant to amphibious warfare. - Continued research in characterizing patterns of life from persistent track data. - Continued research on technologies needed to enable multi-INT sensors to collaborate in real time on complex fusion tasks. - Continued a project to enable the synchronized planning and management and ISR assets given a set of disparate mission information requirements. - Continued effort to represent disparate data as a reduced feature vector. - Continued research in analytics for limited and isolated computational environments to enable advanced analytic capabilities to be available on expeditionary lightweight computing platforms. - Continued research on technologies needed to produce products from multi-modal information in response to information requirements by leveraging cloud data access capabilities. - Continued research in representing the content of large data stores in a way that allows remote and accurate searching against data indexes to be enabled. - Continued research on collapsing networks inferred from disparate data sources. - Completed development of information fusion technologies to allow automated construction of a common tactical picture from various sources of sensor data. - Completed development of tagging, tracking and locating technologies to monitor adversary movement. - Completed development of a single, integrated, battlespace picture with tactical and strategic injections that begins to close the gap between ISR and C2. - Completed research on the development of networked, ultra-low power, long life and smart ground sensors. - Completed research on technologies needed to tailor information delivery to warfighters based on mission context and user preferences.					
FY 2017 Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2016, less those noted as completed above. - Complete work on specific nanomaterial triggers and receptors. - Complete development of urban sensing technologies to detect weapons at distance. - Complete work on new optical taggants with improved producibility. - Complete development of low power consumption urban sensing technologies. - Complete development of information on demand technologies to provide the warfighter with the right information at the right time. - Complete efforts addressing "battlespace awareness" of human networks, improving the accuracy of classification decisions and enabling a human network predictive capability. Once a human network sensor can be defined and dynamically observed in a common feature space, predictive capabilities are realized. If one network is observed to be moving towards at risk behavior, a generalized force warning may be enabled addressing the threat associated with all networks with similar human network sensors. When combined, research into human network awareness, network classification and network prediction, will be a powerful tool for warfare against the irregular actor. - Complete research in automated techniques to establish the reliability of data from human and machine sources. - Complete development of advanced analytics (data disambiguation, conditioning, fusion and dissemination) as a set of map reduce tasks that can run across highly distributed data architecture. - Complete research on the automated deconfliction and fusion of multi-intelligence tracks on movers of interest, enabled by a rich maritime ontology and active wiki technology. - Complete research in characterizing patterns of life from persistent track data. - Complete research on collapsing networks inferred from disparate data sources. - Complete research in representing the content of large data stores in a way that allows remote and accurate searching against data indexes to be enabled. - Initiate effort to mature machine vision classifiers to the detection of specific objects from airborne video. - Initiate effort to represent graph based representations of the information content of a cloud that can be shared over limited bandwidths between clouds. - Initiate effort to develop advanced query capabilities on no-SQL data bases. - Initiate effort to develop novel analysis capabilities applicable to open source data.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete development of distributed information architecture technologies.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Actionable Intelligence for Expeditionary and Irregular Warfare effort which includes real-time methods for Identifying Human Networks. - Complete development of adaptable enemy course of action engine to manipulate adversary decisions. - Complete efforts to track entities of interest in a high clutter environment via geolocation of optical tags from a UAV platform. - Complete efforts to derive high resolution models of human networks statistically, with associated behavior attributes. - Complete technology development efforts required to enable a lightweight hyperspectral sensor capable of material characterization. - Complete research on technologies needed to produce products from multi-modal information in response to information requirements by leveraging cloud data access capabilities. - Complete effort to mature machine vision classifiers to the detection of specific objects from airborne video. - Initiate effort connecting tactical clouds to each other and connecting tactical clouds to traditional Marine Corps Tactical Service Oriented Architecture environments. The goal is that each cloud and non-cloud instance is able to replicate all (but only) mission critical data in a bandwidth efficient manner. - Initiate research on using machine learning to project Measures of Effectiveness Performance based on Common Tactical Picture and Common Intelligence Picture content and on autonomous tactical decision support tools informed by these projections. - Initiate research on using artificial intelligence to compose and trigger analytic workflows based on the content of big real-time data streams and research on training classifiers to predict links between insurgent groups and between insurgent groups and other entities over time. - Initiate research on computational accuracy throttling and power mitigation strategies for real-time processors operating under constrained and fluctuating power resources. ***FY 2018 OCO Plans:*** N/A					
Title: USMC FUTURE NAVAL CAPABILITIES ***Description:*** This R-2 Activity, formerly named Littoral Combat/Power Projection (LC/PP), addresses the applied research associated with the Marine Corps' participation in the Department of the Navy's (DoN) Future Naval Capabilities (FNC) Program. Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0602750N, where the Navy's participation in the FNC Program is funded. The FNC Program represents the requirements-driven, delivery-oriented portion of the DoN Science and Technology (S&T)	8.613	10.825	4.730	0.000	4.730

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
portfolio. FNC investments respond to Naval Technology Gaps generated by IPTs that are co-managed by Navy and the Marine Corps flag/general officers with representation across the naval research enterprise. FNC funding is aligned to naval challenges that may be associated with any of the FNC focus areas (i.e., Pillars). FNCs contain both 6.2 Applied Research and 6.3 Advanced Technology Development Budget Activity (BA) components as technology is matured from a Technology Readiness Level (TRL) of 3 or 4 to a TRL of 6. The FY2016 to FY2017 increase was due to a rephasing of the Tactical Edge Enabling Capability products of Actionable Information Tactical Applications, Data Condition, and Network Adaptive Communication Services. The FY2017 to FY2018 decrease in the USMC Future Naval Capabilities activity is due to a realignment of funds to the Expeditionary Cyber Activity. Additional funding realignment within PE 0603640M Marine Corps Advanced Technology Demonstration ensures that the Future FNC funding will remain constant in USMC program elements. ***FY 2016 Accomplishments:*** - Continued Automated Processing for Spectral Exploitation and Dissemination (APSED) - Develop autonomous cueing algorithms. - Continued Compact Wide Area Reconnaissance and Spectral Sensor (CWARSS) - Research and assess compact processing and storage hardware for sensor management, image refinement and storage, and dissemination. - Continued Radar / Context Fusion - Research and design software algorithms to summarize Human Intelligence (HUMINT) data as a spatial threat surface. - Continued Radar Fusion and False Track Mitigation - Improve real-time algorithm effectiveness within the relevant environment. - Continued Data Conditioning - Research and design machine content extraction algorithms and algorithms capable of formatting a structured report. - Continued Network Adaptive Communication Services - Research and design a software policy specification that uses inputs from mission priorities, users and data conditioning that is based on Dynamic Tactical Communications Network (DTCN) prioritization. - Continued development of the Ground Based Air Defense On-the-move high energy laser demonstrator (GBAD). - Completed development of technologies to enable the exchange of actionable information at the tactical edge.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed development of the Azimuth and Inertial Micro-electromechanical System (MEMS) Navigation System (AIM). - Completed development and transition of Expeditionary Fighting Vehicle (EFV) obstacle detection capability to EFV Direct Reporting Program Manager (Expeditionary Fighting Vehicle Obstacle Avoidance System (EFVODS)). - Completed EMW-FY12-03 Wide Area Surgical And Persistent Surveillance (WASPS). ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. This includes EMW-FY16-01 Densified Propellant Fire From Enclosure - Confined Space(FFE/CS) Propulsion Technologies that was previously funded by PE 0602750N Future Naval Capabilities Applied Research in FY 2016. - Complete SHD-FY13-02 Ground Based Air Defense On-The-Move (GBAD). - Complete Radar Fusion and False Track Mitigation - Improve real-time algorithm effectiveness within the relevant environment. - Initiate EMW-FY17-01 High Reliability DPICM Replacement (HRDR). This effort will increase the legacy 155mm Dual Purpose Improved Conventional Munition (DPICM) projectile cannon fired sub-munition reliability to at least 99% and allow the Marine Corps to retain an anti-personnel/anti-armor, artillery-based Area Effect Munition (AEM) capability. - Initiate EPE-FY16-01 Advanced Topcoat Systems for Ground Vehicle (ATS-GV) - Continue development of isocyanate free topcoat resin systems for the ground vehicle. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete EMW-FY16-01 Densified Propellant Fire From Enclosure - Confined Space(FFE/CS) Propulsion Technologies. - Initiate EMW-FY18-01 ACV 1.X Fuel Efficient Technology Suite - Research and analyze initial requirements to develop a suite of technologies that will significantly increase platform reach and range, and reduce the logistical footprint. - Initiate Marine Corps portion of EMW-FY18-01 ACV 1.X Water Speed Enhancement (this effort is co-funded in PE 0602750N Future Naval Capabilities Applied Research) - Conduct Modeling and Simulation studies to design an optimal hull form and various propulsor concepts. ***FY 2018 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: LOGISTICS	5.528	5.833	5.789	0.000	5.789

Description: This activity supports Marine Corps Expeditionary Logistics which is the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. Expeditionary Logistics replaces mass with assured knowledge and speed, is equally capable ashore or afloat in austere environments, and is fully scalable to meet uncertain requirements. Expeditionary Logistics logically divides into four pillars: efficient and responsive force sustainment, planning and directing logistics operations, logistics demand reduction, and fleet maintenance. These pillars are thoroughly integrated and perpetually related in execution.

FY 2016 Accomplishments:
- Continued development of water purification applied research focused toward small personal water purification devices. This includes previous work in an energy recovery system for enhancing the efficiency of small reverse osmosis water purification devices.
- Continued applications of advanced material surface treatments and coatings for reducing required maintenance and enhancing operational readiness of expeditionary warfare vehicles, machinery, and electrical systems (Note: This also includes development of alternative human load carrying concepts to lighten the load carried by the Marine and reduce structural damage to the human body).
- Continued applied research toward materials that will reduce, or prevent, wear and corrosion on systems and equipment.
- Continued the development of advanced water location, harvesting, packaging, distribution, and quality monitoring systems to enable Marines to be fully self-sufficient for water resources on the battlefield.
- Continued operations research and analysis efforts to enhance seabased expeditionary supply chain concepts and technologies.
- Continued development of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain.
- Continued the development of modular thermoacoustic systems capable of acting as power generation or heat-pump devices.
- Continued the development of energy scavenging technologies to minimize wasted thermal, RF, kinetic, and other energy on the battlefield.
- Continued development of high efficiency, high specific power, rugged, and inexpensive solar photovoltaic energy harvesting technologies.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed the development of logistics C2 systems for optimizing the transportation of materiel across multiple intra and inter-theater connector vehicles (aka: Transportation Exploitation Tool). - Completed development technologies to facilitate cargo transfer across intra-theater logistics connector vehicles, to include advanced material handling equipment as well as asset tracking and reporting technologies.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete development of water purification applied research focused toward small personal water purification devices. This includes previous work in an energy recovery system for enhancing the efficiency of small reverse osmosis water purification devices. - Complete applications of advanced material surface treatments and coatings for reducing required maintenance and enhancing operational readiness of expeditionary warfare vehicles, machinery, and electrical systems - Complete the development of advanced water location, harvesting, packaging, distribution, and quality monitoring systems to enable Marines to be fully self-sufficient for water resources on the battlefield. - Complete operations research and analysis efforts to enhance seabased expeditionary supply chain concepts and technologies. - Complete development of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain. - Complete the development of modular thermoacoustic systems capable of acting as power generation or heat-pump devices. - Complete the development of energy scavenging technologies to minimize wasted thermal, RF, kinetic, and other energy on the battlefield. - Initiate the development of stochastic studies to model and insert Additive Manufacturing into the Naval Supply Chain. - Initiate the development of a project to investigate the complex physical processes occurring associated with complex geometries when using laser directed energy metal deposition processes with titanium alloys. - Initiate the development of a project to investigate the feasibility and attributes of the wireless transfer of power technologies for dismounted Marines.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete the development of stochastic studies to model and insert Additive Manufacturing into the Naval Supply Chain.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete the development of a project to investigate the feasibility and attributes of the wireless transfer of power technologies for dismounted Marines. ***FY 2018 OCO Plans:*** N/A					
Title: MANEUVER ***Description:*** The Maneuver thrust area focuses on the development of technologies that will increase the warfighting capabilities and effectiveness of the Marine Air-Ground Task Force (MAGTF). This thrust aims at capturing emerging technologies in the areas of mobility, materials, propulsion, survivability, durability, signature reduction, modularity, and unmanned systems. Emphasis on survivability technologies includes defeat of small arms, IEDs, mine blast, and RPGs. Efforts also continue in the development of modeling and simulation tools that integrate many different physics based modeling systems with rigorous operational analysis simulations to accurately define a system's performance characteristics. These tools will aid in defining the trade space for emerging technologies and assist in providing the program manager insight and guidance into pursuing future technologies. The Thrust is also providing the USMC with affordable technologies that enable manned-unmanned teaming, autonomous vehicle collaboration, and ground vehicle mobility technologies for enhanced expeditionary maneuver. The FY2016 to FY2017 increase in funding is due the re-phasing of the initiation of technology development programs to address expeditionary maneuver capability gaps. ***FY 2016 Accomplishments:*** - Continued lightweight Expeditionary Systems Materials (ESM) efforts to determine feasibility of scaling and producing candidate structural armor. - Continued mobility enhancement development effort for current and future light and medium weight Marine Corps vehicle programs. - Continued efforts addressing technologies to mitigate acceleration and traumatic brain injuries to vehicle occupants. - Continued efforts addressing advanced suspension systems with ride height adjustment capabilities, adjustable ride quality capabilities, rollover prevention, and load equalizing systems to enhance tactical mobility and survivability. - Continued efforts addressing improvements in vehicle fuel efficiency by improvements in drive train efficiencies, engine efficiencies and alternative fuels capabilities to enhance tactical mobility.	6.745	7.950	7.837	0.000	7.837

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued technology development programs to address maneuver capability gaps in survivability such as an advanced seat technology effort to improve/increase occupant protection within the platform by reducing injury due to the effects of dynamic blast events and accidental vehicle rollover. - Continued technology development programs to address maneuver capability gaps in Mobility such as a Vehicle Stability effort to improve/increase vehicle performance characteristics such as reducing vehicle rollover tendencies. - Continued efforts in advanced perception and context-based reasoning aimed at the development of an autonomous vehicle capability that will provide mobility and logistics support to the dismounted Marine during Enhanced Company Operations (ECO). - Continued the development of autonomy technologies and system concepts that will enable unmanned ground vehicles (UGVs) to be used as autonomous logistic connector vehicles. - Continued lightweight armor, material, and structural technologies that enable maneuver and survivability of small, light expeditionary platforms. - Continued survivability technologies that enable defeat of all unitary and tandem RPG and select Anti-Tank Guided Missile (ATGM) threats, and the demonstration of survivable vehicles. - Continued non-GPS localization technologies such that autonomous vehicles can navigate in areas where satellite data is inaccessible. - Continued the development of technologies that enable vehicle component modularity and reduce life cycle costs. - Continued mobility technologies that enable improved vehicle agility and stability. - Continued Advanced Mobility efforts in Future Fuel Alternatives and Advanced Propulsion and Suspension Technologies to improve vehicle fuel efficiency through improvements in drive train and engine efficiencies and alternative fuels capabilities to enhance tactical mobility. - Continued the development of technologies that sustain vehicle components longer and reduce life cycle costs. - Continued the development of autonomous technologies automating behavior generation and enabling adaptive behavior using virtual environments. - Continued technology development programs to address expeditionary maneuver capability gaps. - Continued the development of fuel saving vehicle technologies, including advanced transmission, power train, and electrical power system technologies. - Continued the development of autonomous technologies by enhanced human machine interface (HMI) through gestures and natural language understood by unmanned ground systems (UGS). - Continued survivability technologies to provide reduction in the probability of detection in a given background.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed the development of autonomous technologies transcribing vision-based perception data in order to be understood by a context-based reasoning system enabling adaptive behavior. - Completed development of Advanced Electro-Magnetic Armor (AEMA) for ground vehicle survivability. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. - Initiate technology development programs to address expeditionary High Water Speed capability gaps. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete advanced seat technology effort to improve/increase occupant protection within the platform by reducing injury due to the effects of dynamic blast events and accidental vehicle rollover. - Initiate development of cognitive reasoning systems that enable manned-unmanned teaming with high levels of autonomy. ***FY 2018 OCO Plans:*** N/A					
Title: EXPEDITIONARY CYBER ***Description:*** This activity supports the Cyber Applied Research program which is intended to provide freedom of maneuver and influence in the Cyber-Electronic Warfare domain while simultaneously denying the same to the adversary and protecting critical command systems. Technologies are being developed using a multi-disciplinary approach that combines RF electronics, digital signal processing, computer engineering, software engineering, machine learning and data science to support Naval Expeditionary warfighters operating with size, weight and power constrained equipment in disrupted, intermittent, low bandwidth environments (DIL). Areas of applied research include distributed precision time, predictive software defined radio architectures, coordinated Cyber and Spectrum maneuver to mitigate detection and exploitation, tactical Cyber visualization, discovering and mapping networks in dense urban environments, contextual awareness and blind channel characterization. Effective 2018 all USMC 6.2 Cyber Technology was transferred from C4 to Expeditionary Cyber. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:***	0.000	0.000	6.790	0.000	6.790

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A ***FY 2018 Base Plans:*** - Initiate a USMC Expeditionary Cyber Applied Research Technology Activity addressing Cyber at the tactical edge. - Initiate cognitive blind channel characterization. - Initiate predictive software defined radio architecture. ***FY 2018 OCO Plans:*** N/A					
Title: FUTURE CONCEPTS, TECHNOLOGY ASSESSMENT, AND ROADMAPPING ***Description:*** This activity supports the planning and integration of technology development efforts across the entire PE. In conjunction with the Concepts Based Capabilities System and the Marine Corps Warfighting Laboratory, unique and novel concepts for advanced warfighting are developed and validated. Effectiveness analyses are conducted to identify the synergistic effects that can be achieved through the integration of emerging technology with innovative tactics, doctrine, and techniques. Technology assessments are conducted to determine the supporting technologies that have the highest impact across the warfare areas, and warrant further investment within this PE. Technology Roadmapping is conducted to help identify opportunities to leverage technology development within the Department of the Navy and the Department of Defense, as well as, with the commercial sector and university communities. The resultant technology investment strategy is developed and used to guide out-year technology development efforts. ***FY 2016 Accomplishments:*** - Continued planning and integration of technology development efforts to meet imposing security threats that challenge our Nation. - Continued a review and assess the Marine Corps' required surface connector capabilities specifically exploring promising and relevant research, technologies, capabilities and opportunities by which the Marine Corps can anticipate and identify potential solutions that meet the service's surface connector requirements. - Continued a technology assessment for a Cyber/Electronic Warfare Coordination Cell (CEWCC) to enable seamless integration of kinetic and non-kinetic fires during expeditionary operations. - Completed a careful analysis of trends that can identify emerging changes in the security environment that are likely to have significant implications for U.S. ground forces. The output will be used to reduce risk and hedge against the surprises that will inevitably occur.	1.377	1.532	1.455	0.000	1.455

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated a review and assessment of Expeditionary Force 21. This new USMC concept describes how the Marine Corps must deploy and operate, and what force attributes will be required. This study will describe Expeditionary Force 21 implications for S&T. Nested directly under Cooperative Strategy 21 (Naval Strategy), Expeditionary Force 21 covers a 10-year planning horizon that informs, and is informed by, other USMC concepts and documents. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. - Complete a technology assessment for a Cyber/Electronic Warfare Coordination Cell (CEWCC) to enable seamless integration of kinetic and non-kinetic fires during expeditionary operations. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete a review and assessment of Expeditionary Force 21 (including revisions). This new USMC concept describes how the Marine Corps must deploy and operate, and what force attributes will be required. This study will describe Expeditionary Force 21 implications for S&T. Nested directly under Cooperative Strategy 21 (Naval Strategy), Expeditionary Force 21 covers a 10-year planning horizon that informs, and is informed by, other USMC concepts and documents. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	44.371	51.590	53.936	0.000	53.936

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this PE is the development of technologies to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare and Combating Terrorism. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602131M / *Marine Corps Lndg Force Tech*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	5.793	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.793

A. Mission Description and Budget Item Justification

These Congressional Cyber funds were provided to develop a multi-disciplinary science and technology strategy addressing dynamic cyber defense and Expeditionary cyberspace operations in support of distributed Naval Expeditionary Warfighters. This was accomplished through examination of prototyping and developing technology capabilities for Expeditionary Cyberspace Operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Cyber Research	5.793	0.000
FY 2016 Accomplishments: - Initiate a multi-disciplinary science and technology effort addressing dynamic cyber defense and tactical cyberspace operations.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	5.793	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Deliverables include a multi-disciplinary science and technology strategy addressing dynamic cyber defense and Expeditionary Cyberspace Operations.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602235N *I Common Picture Applied Research*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing
0000: *Common Picture Applied Research*	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing

Note

N/A

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric S&T investments.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	42.538	41.185	37.916	-	37.916
Current President's Budget	42.973	41.185	36.450	-	36.450
Total Adjustments	0.435	0.000	-1.466	-	-1.466
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.107	0.000			
• SBIR/STTR Transfer	-0.672	0.000			
• Program Adjustments	0.000	0.000	-1.466	-	-1.466

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602235N *I Common Picture Applied Research*			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602235N / *Common Picture Applied Research*	Project (Number/Name) 0000 / *Common Picture Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Common Picture Applied Research*	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 January 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric S&T investments.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: COMMUNICATION AND NETWORKS	6.975	7.194	7.283	0.000	7.283
Description: The overarching objective of this activity is to develop high throughput dynamic wireless communications and network technologies critical to the mission performance and robustness of naval communications for widely dispersed, mobile air, land, surface and submerged platforms. These platforms are often size, weight and power (SWaP) limited, and will operate under constraints of cluttered radio frequency (RF) spectrum, harsh electro-magnetic interference (EMI) and Beyond Line Of Sight (BLOS) conditions. The technical payoff is increased network data rates, interoperability across heterogeneous radios, dynamic bandwidth management, and greater mobile network connectivity. The operational payoff is that warfighters from the operational command to the tactical edge have near real-time access to information, knowledge and decision-making necessary to perform their tasks, including coalition and allied forces. Emphasis is on tactical edge communications and networks to fully realize net-centric warfare, bridging the Global Information Grid (GIG) and the 'disadvantaged user', e.g., small-deck combatants, submarines, unmanned vehicles, distributed sensors and ground units in urban and RF challenged environments. The current specific objectives are:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602235N / *Common Picture Applied Research*	**Project (Number/Name)** 0000 / *Common Picture Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
a) Radios and Apertures: Develop technologies for high band radio, electrically-small and actively scanned antennas, addressing critical issue of radio spectrum bandwidth efficiency, spectrum contention and clutter, agile frequency communications with dynamic spectrum access, all-digital front-end with wide dynamic range, power amplifier efficiency, multipath effects, saltwater propagation and BLOS communications. Develop algorithms and signal processing for space-time-frequency diversity communications, including measures for electronic protection, such as low-intercept, antijam waveforms and modulation. Develop affordable antenna technologies for small size and weight, high radiation efficiency, and wideband operation with rapid beam-steering. Develop alternatives to RF communications in airborne and terrestrial environments as well as high data rate underwater communications for undersea warfare (distributed sensor netting, unmanned underwater vehicle data exfiltration, submarine Communications at Speed and Depth) using electro-optic/infra-red (EO/IR) technologies. Develop secure, high bandwidth communications systems and the exploitation of existing and emerging network protocols that will avail development of new, Low Earth Orbit (LEO) based data transport mechanisms. b) Tactical Networking and Network Control/Management: Develop advanced networking techniques for robust, highly dynamic environments; interoperable networks for secure communications and protocols, bandwidth and network management techniques that manage and allocate bandwidth across tactical and theater levels in support of net-centric operations. Develop rapidly auto-configuring and self-organizing networks with efficient and survivable routing, secure authentication, mobility management and Quality-of-Service guarantee, while optimizing network resources. Address low bandwidth, synchronization and reliability for Service Oriented Architecture (SOA)/middleware architecture in both mobile ad-hoc networks (MANET) and infrastructure-based Internet Protocol (IP) backbone networks. Develop cognitive network planning and operations engines whose criteria are based directly on mission objectives, while self-adapting and managing the spectrum allocation and radio resources in such a way that network operations, SOA community of interest, and computer network defense are integrated to form a single common tactical network picture that requires a minimum of human intervention and skill. Develop technology for improving tactical edge networking and for improving voice communications. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Radios and Apertures: - Continued design and development of electronic protection for high frequency communications.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued technologies to improve spectrum co-existence of military waveforms with commercial communications (e.g., overlay/underlay techniques, interference cancellation, machine learning and reasoning algorithms for distributed spectral awareness/management, etc.). - Continued development of low cost approaches for electronic beam steering and multi-beam radio frequency systems. - Continued development of technologies to enable troposcatter communications on the move with reduced size, weight, and power antennas. - Continued development of blue-green filter technologies with wide field of view, narrow bandwidth, and reduced size, weight, complexity, etc. - Continued design and development of electronic protection for HF communications. - Completed development of integrated metamaterial antennas for ship and ground platforms. - Completed demonstration of high peak power, short pulse operation of fiber lasers in blue-green region. - Completed development of blue-green receiver and detector technologies with greater sensitivity, while reducing size, weight, power, and/or cost. Tactical Networking and Network Control/Management: - Initiated the development of software-defined networking capabilities for tactical platforms. - Continued dynamic routing mechanisms that focus on robust data delivery -- in near real time -- under harsh networking conditions (i.e.,intermittent connectivity, limited throughput, etc.). - Continued development of techniques and algorithms to manage resources of tactical networks in a manner consistent with Commander's Intent. - Continued development of techniques and algorithms to ensure end-to-end delivery of data across undersea networks with large delays and multi-modal communications. - Completed design and development of cognitive netops for tactical communications.					
FY 2017 Plans: Radios and Apertures: - Continue all efforts of FY 2016 less those noted as complete. - Complete design and development of electronic protection for HF communications. - Initiate the development of novel antenna technologies for communications with small satellites. - Initiate the development of optical technologies for tracking and communications with small satellites. - Initiate the development of interference alignment and chaotic waveform techniques for secure communications.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate development of MEMS enabled reflectarray phased array antennas. Tactical Networking and Network Control/Management: - Continue all efforts of FY 2016 less those noted as complete. - Complete development of techniques and algorithms to ensure end-to-end delivery of data across undersea networks with large delays and multi-modal communications. - Initiate development of performance-aware dynamic communication protocols (including multicast with network coding) that adapt to varying network conditions and application requirements. ***FY 2018 Base Plans:*** Continue research in antenna technology to include electrically small antennas, wideband multifunction antennas, compatibility of phased array antennas with naval platforms and marine environments, directional beam forming/steering techniques, and special-purpose submarine communication antenna systems; radio communications to include anti-jam and low-probability-of-intercept techniques, SATCOM performance enhancements, interference mitigation, adaptive equalization, bandwidth efficient modulation, cognitive radio for dynamic spectrum management, and high data rate tactical communications techniques including communications at speed and depth (for submarines); and wireless networks to include mobile ad-hoc wireless networking algorithms/protocols, end-to-end Quality-of-Service, joint/coalition interoperability, service oriented tactical networking, mission-based policy and network controls and management. Continue network-centric and information warfare capability for the Navy/Marine Corps by addressing deficiencies and science gaps in tactical networks. These capabilities address unique military environment and application challenges enabling new mission concepts requiring minimal human intervention. Focus on three specific objectives: dynamic network structural analytics and adaptation; robust network organization and transport, distributed group collaboration and discovery; and adaptive signaling and sensing to improve military wireless communications. Demonstrate a digital design receiver testbed for compressed sensing techniques for a communications relay; and real time application of analytic complex network theory metrics to both aid the prediction of network performance and to assist a cyber tool to identify and track network strengths and weaknesses. ***FY 2018 OCO Plans:*** N/A					
Title: APPLIED INFORMATION SCIENCES FOR DECISION MAKING	24.366	25.225	22.519	0.000	22.519

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: The goal of this activity is to develop enablers for decision making and mission execution, to achieve battlespace superiority. It focuses on the development of algorithms and software technologies that identify and integrate informational content from multiple sources, leading to decision aids that support user-cognitive processes. Because persistent sensors are generating massive amounts of data, the focus is on technologies that not only integrate information from diverse sources, but also provide indications of information significance in ways that support the user's decision needs, regardless of location and operational situation. To achieve this, it must be possible to automate understanding of the battlespace by identifying objects, determining relationships among the objects, assessing intent, and automatically generating courses of action with associated risks and uncertainty. Effort will also be devoted to developing technology for increasing assurance and security for C3 information systems and technology for improving information discovery and information presentation in such systems. The Nano Electronics Technology activity is focused on developing ultra-low power, higher performance computing devices and components that are based on novel functionalities of nanometer scale materials and are enabled by improved understanding of nanomaterials, new devices and circuit design concepts, as well as new architectures uniquely suited for nanoscale systems. Funding increase from FY16 to FY17 is a result of increased research in Cyber Defense. Funding decrease from FY17 to FY18 is a result of the completion of Cyber Investment Management Board Initiative (CIMBI) Gap Mitigation effort. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Data Understanding: - Initiated efforts for reconstructing events from a loose network of heterogeneous cameras. - Continued development of algorithms for extraction of information from Light Detection and Ranging (LIDAR) and Radar. - Continued efforts to develop an automated tool to improve checkpoint security by identifying accents of non-native English speakers. - Continued development of methods for integration of low-level image processing and high-level knowledge for simultaneous image segmentation and object recognition, and visual reasoning for image understanding. - Continued development of 3D image processing for object recognition and meaningful change detection.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of modular, interactive, intelligent, video-based surveillance systems. - Continued methods for building sophisticated visual knowledge bases, development of methods for visual reasoning and integrating them in image/video understanding, and development of methods for image description. Information Integration: - Continued development of methods for analysis and integration of text with imagery and video. - Continued development of methods for analysis of structured and unstructured data. - Continued development of algorithms and tools for information representation of unstructured data and structured data in such a way that shared concepts/relationships in disparate data sets can be automatically compared, matched, or associated, and in a way that can facilitate and improve information fusion. - Continued development of algorithms and tools for information fusion of heterogeneous data for classification and reconstruction based on high level features inherent in each data source, with the goal of forming a more complete picture of battlespace environment. - Continued development of algorithms and tools for discovering and extracting higher-level features -- objects, events, patterns, intents, relationships, anomalies -- from various data types in support of future asymmetric warfare. - Continued research to extend user interfaces for immersive simulation to enable users to better express themselves through non-verbal communications. - Continued research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. - Furthered research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. - Completed research to extend user interfaces for immersive simulation to enable users to better express themselves through non-verbal communications. Data Analytics (Formerly Titled: Mission Focused Autonomy (MFA) - Initiated Maritime domain awareness toolkit development for small vessel tracking. - Initiated cyber information awareness decision tools for hull, mechanical and electrical security for Naval vessels. - Continued bringing capability into a multi-level security environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue automating current set of time critical reports to ensure timely decision making that is informed by forensics data. - Continued efforts to develop a task scheduler for unmanned aerial system operators that reflects operator workload. - Continued research in mission-focused autonomy and reasoning methods; expanded autonomy from simple platform. kinematics to include all-source information exploitation and surrounding cultural and social influences. - Continued integrating this analytic environment into parallel Navy Tactical Cloud environment. Resource Optimization: - Continued development of methods for selecting sensors and platforms for search and surveillance operations in a theater, allocating the selected sensors and platforms to specific missions, operating the allocated sensors during a mission, and fusing the information from the sensors and other sources. - Continued development of optimization-based decision aids for resource allocation, such as those required for mission planning at the strategic, operational, and tactical level. Cyber Defense: - Initiated development for methods and tools for semi-/fully- automated software model extraction and online program execution monitoring toward achieving adaptive and resilient computing system. - Continued development of anti-tamper methods that are capable of lengthy operation in unattended and un-powered environments, have very high probability of tamper detection and very low probability of false alarm, and remain undetected in the host system. - Continued development of automated tools that identify and mitigate potential software vulnerabilities, such as tools that analyze code as it is being written, vulnerability-aware compilers that automatically enhance code security, and techniques for enhancing the client-side security of web applications. - Continued research into better protecting Department of Defense systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. - Furthered research into better protecting Department of Defense systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. Nanoscale Electronics:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued effort to develop a highly linear, low-noise radio frequency amplifier using aligned arrays of single-walled carbon nanotubes. - Continued new research in graphene synthesis and device concepts. - Continued effort to develop the synthesis, fabrication and testing of graphene-based electromechanical structures and devices. - Continued work on graphene-based devices and circuits for low power flexible electronics. - Continued research on graphene-organic hybrid materials interfaces and device structures. Quantum Information Sciences: - Continued free-space Quantum Key Distribution applied research program for secure communication. Network Situation Awareness & Security: What happened to this Project? - Continued development of algorithms/methods for providing attribution of threat-agents through the network/ infrastructure. Emphasis will be placed on addressing translational boundaries, cross-domains, and obfuscation techniques to avoid detection and tagging. - Continued new mobile agent technology that provides network protection, thwarts botnet attacks, and provides for a resilient computational infrastructure and communications environment. Investigate new methods for subverting the control plane of the mobile code attacking the infrastructure. - Continued development of algorithms/methods for providing attribution of threat-agents through the network/ infrastructure. Building upon previous results, develop network-based techniques to provide pro-active response to attributed threat agents to mitigate attack vector and ensure mission success. - Continued investigating new methods for subverting the control plane of the mobile code attacking the network infrastructure. - Continued the development of new algorithms for taking control of bots once the control plane is compromised. - Continued development of new algorithms/techniques to characterize Navy and Marine Corps network assets in order to develop robust security mechanisms and support technologies based on criticality and mission essential operations. Network Traffic Analysis and Assessment: - Continued development of new algorithms focused on detection of nation state sponsored activities through the network infrastructure. Develop algorithms to address sophisticated malicious code techniques.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued algorithms to address sophisticated malicious code techniques that exploit network traffic/data that is fragmented, encrypted, and/or obfuscated using polymorphic methods, as well as techniques that transgress security perimeters and exfiltrate data. - Continued development of new algorithms that provide attack prediction and targets of opportunity. - Continued the development of algorithms and techniques to detect stealthy protocols that enable covert communication by exploiting channels available in existing widely used protocols. Information Assurance: - Continued the development of methods and techniques to provide component repurposing/agility to flatten the attack surface from sophisticated nation-state sponsored attacks. - Continued the development of trusted computing technologies to minimize/limit authentication/sign-on services across various network, virtual, and/or cloud environment.					
FY 2017 Plans: Data Understanding: - Continue all efforts of FY 2016 less those noted as complete above. - Complete efforts to develop an automated tool to improve checkpoint security by identifying accents of non-native English speakers. Information Integration: - Continue all efforts of FY 2016, less those noted as completed above. - Complete research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. Data Analytics (Formally Titled Mission Focused Autonomy (MFA): - Continue all efforts of FY 2016, less those noted as completed above. - Complete efforts to develop a task scheduler for unmanned aerial system operators that reflects operator workload. Resource Optimization: - Continue all efforts of FY 2016, less those noted as completed above.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Cyber Defense: - Continue all efforts of FY 2016, less those noted as completed above. - Furthering research into better protecting DoD systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. Nanoscale Electronics: - Continue all efforts from FY 2016, less those noted as completed above. Quantum Information Sciences: - Continue all efforts of FY 2016, less those noted as completed above. Network Situation Awareness & Security: - Complete all efforts of FY16 Network Traffic Analysis and Assessment: - Complete all efforts of FY16 Information Assurance: - Complete all efforts of FY16					
FY 2018 Base Plans: Information Technology: Initiate research to improve the operational capability of Naval decision support systems and decrease the cost of these systems through transformative advances in information management that enables agility in timely and accurate decision and action. The military capability from this task area is technology to support improved situational awareness and operational effectiveness, improved techniques for dealing with information-intensive applications, and information management processes that improve the speed and accuracy of decisions and actions. Electromagnetic Warfare: Initiate research in advancing the state-of-the-art in being able to uniquely identify target of interest in very complex environments using passive technologies to assure high confidence to the decision maker when					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
combined with other information sources. This is being accomplished by expanding specific emitter identification technologies into areas detecting previously unaddressed and unexplored with the intent of maintaining battlespace superiority. Quantum Information Sciences: Continue research of quantum key distribution (QKD) protocols and implementations for the purpose of understanding the security implications for QKD in the maritime environment, the development of protocols that simultaneously minimize leakage of information to the environment and the creation of secure networks, as well as schemes to maximize the information carried by a continuous or discrete variable; and research of algorithms for naval functions such as routing, weapon-target pairing, etc., a key application such as radar cross section calculation. Computational Methods for Decision Making (formerly Data Understanding, Information Integration, and Resource Optimization): Continue research of Information Integration, Automated Image Understanding, and Resource Optimization for the purpose of developing innovative methods for combining traditional and non-traditional data from sensors and disparate sources to provide the best estimate of objects, events, and conditions in the battlespace, in terms of their identity, associated error or uncertainty, context, impact, while inferring relationships and their intentions; developing automated, image and signal intelligence understanding tools based on rigorous mathematical and statistical methods that lead to improved change detection, improve object and activity detection and recognition capabilities, context and scene understanding, and inferring of the threat levels to support decision making and persistent and adaptive surveillance; and developing automated decision-support tools based on mathematically rigorous techniques (e.g., mathematical optimization) that support decision-making to ensure the best use of scarce and/or expensive resources, achieving optimal allocations for large complex scenarios, including ones that contain uncertainty, in drastically reduced amounts of time. Develop methods that support decision making in networked sensor management and allocation to ensure sensor assets are deployed in an optimal, or near optimal, manner. Nanoscale Electronics Technology: Continue research in novel nanometer scale (feature size near or below 10nm) logic/memory devices and related circuits and architectures to deliver ultra-low power, light weight and high performance computational capability for autonomous vehicles and individual warfighters.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Cyber Defense: Continue research in cyber systems, leveraging results from basic research program, developing and evaluating technical approaches for future naval capabilities. The program investigates technologies for enhancing efficiency, robustness and cyber resiliency for all classes of computing systems in naval enterprise systems as well as Navy's real-time safety critical cyber physical systems. Data Analytics: Continue research in new approaches to support tactical decision makers and information superiority. This is performed by producing distributed situation assessment of a commander's environment through development of a common tactical picture; developing collaborative, distributed mission plans; monitoring and dynamically replanning mission execution as required; understanding their environment by being able to access distributed heterogeneous enterprise information stores intelligently through use of autonomic software; effectively using sensor information and making resource allocation decisions and information operations. Specific research involves real-time computing, decision aids and collaborative workspaces; secure distributed architectures; and information warfare methods to protect secure information. ***FY 2018 OCO Plans:*** N/A					
Title: MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION ***Description:*** This activity addresses theater air and missile defense (TAMD), and responds to warfighter needs for rapid, high confidence Combat Identification (CID) of air and missile threats at long range, using real time and non-real time threat attributes and intelligence information. Funding decrease from FY16 to FY17 is a result of the completion of the development of Associative Learning signal classification framework. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2016 Accomplishments:*** - Continued development of a new radar signature analysis technique based on nonlinear dynamics. - Continued development of coordinated, multi-platform, multi-component waveforms. - Continued development of a real-time, electronic warfare support, de-interleaving capability. - Continued development of advanced communications emitter identification.	3.818	2.863	1.530	0.000	1.530

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued to develop and demonstrate Multiple Input Multiple Output (MIMO) radar concepts and technology using High Frequency (HF) Skywave radar. - Continued development of electronic protection techniques for long range emitter classification systems. - Continued development of Associative Learning signal classification framework to provide robust automatic target recognition. - Continued development of methodology to incorporate electromagnetic (EM) vector sensors in unmanned surface vehicles (USVs) to enable high frequency signal detection and geolocation. - Continued development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave high frequency radar. - Furthered development of methodology to incorporate EM vector sensors in USVs to enable high frequency signal detection and geolocation. - Furthered development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave high frequency radar.					
FY 2017 Plans: - Continue all efforts of FY 2016. - Furthering development of methodology to incorporate EM vector sensors in USVs to enable HF signal detection and geolocation. - Furthering development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave HF radar. - Complete development of Associative Learning signal classification framework to provide robust automatic target recognition.					
FY 2018 Base Plans: Electromagnetic Warfare (NRL) New algorithmic approaches are being developed to conduct automatic target recognition using associative learning. A small sized design has been built to improve RF detection of targets at HF frequencies as precursors to adversary air attacks. This in conjunction with improvements being made in HF surface wave radar array geometries should greatly improve operational capabilities in this reinvigorated part of the RF spectrum. A new concept for rapidly assessing concurrently multiple missiles with multiple EW responses is being investigated to provide for rapid high quality assessment in this complex environment.					
FY 2018 OCO Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: TACTICAL SPACE EXPLOITATION	5.782	5.903	5.118	0.000	5.118
Description: The Tactical Space Exploitation initiative explores the application of new space craft technologies on small, light-weight and low-cost satellites, to enhance naval warfighting capabilities by taking advantage of the global access, revisit and connectivity provided by orbital platforms. a) Spacecraft Technology: Affordable, expendable payload and bus technologies will be developed, which will serve as building blocks for future responsive space systems: payloads, bus technologies and significant space robotic technologies that address on-orbit inspection, servicing, repair and assembly, and mission-life extension. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2016 Accomplishments:*** - Continued program to use chemical release from satellites launched into selected low-Earth orbits to de-populate intense trapped electrons in radiation belts following a low-altitude nuclear explosion in space. - Continued effort to develop technologies using autonomous, bi-dexterous manipulation for close proximity operations in space. - Continued developing the underlying fluid transfer technologies for steerable radiators that will enable spacecraft thermal radiators to be pointed away from the sun. - Continued developing a proof-of-concept, reliable, touch sensitive skin for robotic arms, with emphasis on space applications, and the associated fault detection and model identification algorithms required to utilize it. - Continued developing the ability to artificially generate and maintain a dust layer in the near earth plasma environment to induce enhanced drag on space debris, aiming toward debris mitigation. - Continued effort to develop the key advanced technologies leading to robust use of space-based electrodynamic propulsion, which will enable spacecraft that perform large scale maneuvers fuel-free, and more cheaply than is currently possible. - Continued effort to design and develop a novel miniature radiation displacement damage sensor that will accurately measure the impact of displacement damage in a space environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602235N / *Common Picture Applied Research*	**Project (Number/Name)** 0000 / *Common Picture Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued efforts to develop a novel actuator and associated control laws that will enable lighter weight architectures for spaceflight robot arms, thereby dramatically reducing size, weight, complexity, and cost of spaceflight robotic manipulators. - Continued efforts to quickly assimilate tracking data of orbiting debris and space objects, while simultaneously shrinking position uncertainties, in order to create more room to operate in space. - Continued efforts to radically reduce thermionic cathode temperature and power by developing the capability for rapid 3D printing of complex cathode parts using the new low-temperature emitter C12A7. - Continued efforts to develop and demonstrate a low power, radiation-hard micro-satellite receiver on a chip which has wide dynamic range and a flexible architecture. - Completed effort to design and develop a novel miniature radiation displacement damage sensor that will accurately measure the impact of displacement damage in a space environment. - Completed effort to develop the key advanced technologies leading to robust use of space-based electrodynamic propulsion, which will enable spacecraft that perform large scale maneuvers fuel-free, and more cheaply than is currently possible.					
FY 2017 Plans: Spacecraft Technology: - Continue all efforts of FY 2016 unless noted as complete. - Furthering efforts to radically reduce thermionic cathode temperature and power by developing the capability for rapid 3D printing of complex cathode parts using the new low-temperature emitter C12A7. - Furthering efforts to develop and demonstrate a low power, radiation-hard micro-satellite receiver on a chip which has wide dynamic range and a flexible architecture. -Complete efforts to develop a novel actuator and associated control laws that will enable lighter weight architectures for spaceflight robot arms, thereby dramatically reducing size, weight, complexity, and cost of spaceflight robotic manipulators. - Complete efforts to quickly assimilate tracking data of orbiting debris and space objects, while simultaneously shrinking position uncertainties, in order to create more room to operate in space.					
FY 2018 Base Plans: Spacecraft Technology Develop advanced, high-payoff technologies that will preserve, protect, and enhance space capabilities in the performance of functions that are of critical importance to Naval operations while also reducing the cost of DoD space activities. Initiate efforts to develop the key tomographic algorithm needed to construct three-dimensional ionospheric electron density from persistent space-based stereoscopic observations, to enable significant					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
passive reduction of Over The Horizon Radar (OTHR) registration errors. Initiate use of the new NRL Loop Heat Pipe transient numerical model and stability theory to design oscillation-free LHPs, to enable precise, reliable spacecraft thermal regulation for higher mission reliability. ***FY 2018 OCO Plans:*** N/A					
Title: AUTONOMOUS SYSTEMS AND ROBOTICS ***Description:*** The Autonomous Systems and Robotics initiative explores the application of new technologies to advance capabilities in the area of robotics, autonomous systems propulsion and control, and integration of autonomous systems. Efforts will be focused on the Assistant Secretary of Defense (Research and Engineering) (ASD (R&E)) priorities in autonomous systems. The decrease from FY 2016 to FY 2017 reflects the completion of the efforts for sustainment of Autonomous Systems and Robotics initiative. ***FY 2016 Accomplishments:*** - Completed all FY15 efforts for sustainment of Autonomous Systems and Robotics initiative. ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A	2.032	0.000	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	42.973	41.185	36.450	0.000	36.450

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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E. Performance Metrics

This PE supports the development of technologies that enable the transformation to network centric warfare. Net-centric operations include communications and information assurance capabilities to enable all-source data access, tailored dissemination of information to Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) users across the network, and rapid, accurate decision making based on this information. The operational benefits sought are increased speed of response, accuracy, and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority.

Specific examples of metrics under this PE include:
- Increase network data rates and interoperability across heterogeneous radios; improve dynamic bandwidth management and mobile network connectivity.
- Increase the understanding of the battlespace by the development of automated tools for extracting information from images and signals, identifying objects, determining relationships among the objects, assessing intent, and generating courses of action.
- Improve the integration of sensors, networks, decision aids, weapons, and supporting systems into a highly adaptive, human-centric, comprehensive maritime system.
- Improve integrated signals electronics packages in small, light-weight, and low-cost satellites to test new concepts for global ship tracking and two-way data exfiltration.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602236N *I Warfighter Sustainment Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	44.092	45.467	48.649	-	48.649	48.448	48.406	48.210	49.131	Continuing	Continuing
0000: *Warfighter Sustainment Applied Res*	0.000	44.092	45.467	48.649	-	48.649	48.448	48.406	48.210	49.131	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan which is developed from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE supports innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on advanced Naval materials; biocentric technologies; environmental quality; human factors and organizational design; medical technologies; and Naval training technologies. Within the Naval Transformation Roadmap, this investment maps to future transformational capabilities and the FORCEnet pillar of the CNO and the Commandant of the Marine Corps vision for the future -- Naval Power 21.

This PE also includes the Office of Naval Research Global (ONRG) International Science Program whose mission is to search the globe for emerging scientific research and advanced technologies to enable the Office of Naval Research (ONR) and the NRE to address effectively the current needs of the Fleet/Forces (F/F), and investigate and assess revolutionary, high-payoff technologies for future Naval missions and capabilities. Within this Global mission is the Naval Science Advisor Program that develops leaders among civilian scientists and engineers in the Naval Research Enterprise (NRE). Upon tour completion, Science Advisors return to the NRE with first-hand knowledge of the F/F, warfighting issues, and strategic decision making. This program enables continuous communication and collaboration between the warfighters, the technical community, and strategic development commands.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602236N *I Warfighter Sustainment Applied Res*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	45.047	45.467	46.269	-	46.269
Current President's Budget	44.092	45.467	48.649	-	48.649
Total Adjustments	-0.955	0.000	2.380	-	2.380
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.254	0.000			
• SBIR/STTR Transfer	-0.701	0.000			
• Program Adjustments	0.000	0.000	2.380	-	2.380
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

The funding increase from FY 2017 to FY 2018 is due to increased emphasis and investment in structural materials applied research.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602236N / *Warfighter Sustainment Applied Res*	Project (Number/Name) 0000 / *Warfighter Sustainment Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Warfighter Sustainment Applied Res*	0.000	44.092	45.467	48.649	-	48.649	48.448	48.406	48.210	49.131	Continuing	Continuing

A. Mission Description and Budget Item Justification

Efforts in this PE focus on; advanced naval materials; biocentric technologies; environmental quality; human factors and organizational design; medical technologies; international science and science advisor programs; and Naval systems training and education.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: ADVANCED NAVAL MATERIALS	9.073	8.689	11.018	0.000	11.018
Description: Advanced Naval Materials efforts support several S&T Focus Areas, in particular Platform Design & Survivability and Power & Energy, and perform research across a broad spectrum of technical areas including: structural materials to increase platform performance and survivability at reduced weight and cost; advanced, high-performance materials for energy systems; corrosion mitigation strategies; high-temperature energy systems; enhanced sonar transducers; and environmental quality technologies. The funding increase from FY 2017 to FY 2018 is due to increased emphasis and investment in structural materials applied research. ***FY 2016 Accomplishments:*** - Continued development of acceptance testing methodologies for advanced transducer, single-crystal, high-strain materials and definition of standardized materials properties and composition ranges. - Continued development of compositional tuning of single-crystal, high-strain transducer materials, for specialized naval system applications. - Continued marine titanium alloy design and processing development, exploiting anticipated cost reductions for high performance, reduced maintenance naval applications. - Continued development of continuous, single wall, carbon nanotube composite materials for next generation air and naval platforms. - Continued stainless steel carburization study to enhance corrosion performance. - Continued development of surface preparation methods and characterization of corrosion performance for future naval ship materials.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602236N / *Warfighter Sustainment Applied Res*	**Project (Number/Name)** 0000 / *Warfighter Sustainment Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued evaluation of low temperature, carburized materials for marine application. - Continued development of coating performance and knowledge database for Naval use. - Continued development of mechanistic model for stress corrosion cracking in Nickel Aluminum Bronze (NAB). - Continued development of innovative sonar transducers based on high-strain, high-coupling, piezoelectric single crystals. - Continued development of novel processing technologies for increasing the fatigue strength and corrosion resistance of weldments for ship structures with reduced weight and maintenance requirements. - Continued development of models and characterization methods for dynamic loading (water slamming and blast loading) in polymer composite materials. - Continued development of fiber-optic sensors, transducers and demodulation technology for structural health monitoring of ships and submarines. - Continued development of continuous based monitoring techniques of new synthetic fuels and lubricants based on electromagnetic signature analysis. - Continued development and application of distributed fiber optic Bragg gratings for structural health monitoring of ships and aircrafts. - Continued development of novel growth methods to specialized single crystal transducer materials tuned to requirements of specialized naval systems. - Continued assessment of the degree of sensitization potential of marine grade Al alloys. - Continued development of surface assessment technologies to measure surface profile and chlorine. - Continued evaluation of advanced material coating for erosion control on helicopter main rotor blade leading edges. - Continued studies on fuel cell corrosion. - Continued development of superhydrophobic surface modification technology. - Continued studies on mitigation of pitting corrosion and stress corrosion cracking in marine aluminum alloys. - Continued development of surface tolerant coating removal methods. - Continued development of processing technologies to fabricate piezoelectric single crystals into complex transducer assemblies. - Continued development of thermal management system(s) to arrest excessive heat fluxes and loads on amphibious ship by advanced Naval/USMC aircraft. - Continued development of the rational engineering design of Al-alloys for naval applications. - Continued to increase emphasis on research efforts to discover innovative fundamental technologies to shape future Naval investments and strategies, leveraging the globe to support the Sailors & Marines of today and tomorrow.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602236N / *Warfighter Sustainment Applied Res*	**Project (Number/Name)** 0000 / *Warfighter Sustainment Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research and development incorporating physics and chemistry of the materials-environment interface, with the focus on materials with melting points above 3000C. - Continued development of quantitative coasting quality assurance tools. - Continued development of advanced Naval Data Environment (NDE), Ship Hazardous Material (SHM), and Prognostics Technologies for improved readiness and reliability of air and naval platforms based on new and emerging electronic and photonics materials and devices. - Continued development of advanced structural composites with improved mechanical characteristics, blast resistance, and fire resistance, for more durable and reliable structures by optimizing the resin, the fibers and the interphases with new chemistries, additives and processes. - Continued development and exploitation of new and advanced forms of carbon based nanostructures (Graphene, Nanotubes, Diamond and others) for next generation family of materials and structures with outstanding mechanical, thermal, electrical and energy applications. - Continued investigating and characterizing cellular structures via additive manufacturing - Continued development of low AC loss high temperature superconductors for advanced power. - Completed investigation of criteria for stable pitting of stainless steel. - Completed acoustic damping coatings for ship tank application. - Completed development of mixed metal nanopowder additives for liquid fuels.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed. - Complete development and exploitation of new and advanced forms of carbon based nanostructures (Graphene, Nanotubes, Diamond and others) for next generation family of materials and structures with outstanding mechanical, thermal, electrical and energy applications. - Complete development of novel processing technologies for increasing the fatigue strength and corrosion resistance of weldments for ship structures with reduced weight and maintenance requirements.					
FY 2018 Base Plans: Expand research on structural materials, including, but not limited to, the following: Nanostructured materials processing, composite development, cellular materials and high temperature materials. Conduct applied research related to critical S&T to investigate corrosion control modeling, acoustic transduction technologies and environmental quality. Complete the development of low AC loss high temperature superconductors for advanced power.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602236N / *Warfighter Sustainment Applied Res*	**Project (Number/Name)** 0000 / *Warfighter Sustainment Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Develop novel and scalable processing methods to produce mechanically robust high temperature superconductor tapes with minimal AC loss for various naval applications such as transformers, inductors, stators and for pulsed power delivery systems for all electric ships. Design new microfluidic system for direct write additive manufacturing to significantly improve the existing techniques. Design of multifunctional material systems for use in new helmet suspension to mitigate multiple threats. Compositional modifications and processing parameters to optimize material performance have been demonstrated. ***FY 2018 OCO Plans:*** N/A					
Title: BIOCENTRIC TECHNOLOGIES	5.608	5.602	5.717	0.000	5.717
Description: Biocentric technologies provide novel solutions for naval needs based upon the applications of bio-inspired sensors, materials, processes and systems. Topic areas include, but are not limited to: development of biologically-based signal processing for medical, surveillance and security applications; bioinspired robotics; synthetic biology to produce high-value naval materials or to develop sentinel organisms, and marine mammal diagnostics to support the Navy's Fleet Marine Mammal Systems. ***FY 2016 Accomplishments:*** NAVAL BIOSCIENCE: - Continued development of innovative naval biosensors, biomaterials, and bioprocess technology. - Continued engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks and AUV's. - Continued development of microbial fuel cells for powering a linear sensor array - Continued study of microbial electrochemical systems for shipboard desalination/waste-to-energy conversion - Continued of closed-loop microbial fuels cells - Continued synthetic biology research on explosive-sensing plants - Continued researched on microbial electrobiosynthesis of liquid fuels SYNTHETIC BIOLOGY FOR SENSING & ENERGY PRODUCTION - Continued synthetic biology studies of engineered sentinel organisms for environmental surveillance LIFE SCIENCE AND BIOENGINEERING - Continued marine mammal diagnostics efforts, including immunobioassays for stress and infection detection. - Continued efforts to detect, treat, and prevent diseases in dolphins, including diabetes and kidney stones.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
NEURAL, SENSORY AND BIOMECHANICAL SYSTEMS - Continued efforts on naval biosensor to detect brain structures and blood vessels through skull bones - Continued efforts on advanced biomimetic sensing and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems. -Continued integration of biomimetic sonar with bioinspired autonomous undersea vehicles (with high-lift propulsors) to achieve closed loop control. - Continued efforts in bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on animal wing and fin biomechanics. - Continued efforts for bio-inspired massively parallel vision systems. - Continued studies to develop brain-based intelligent systems to support high level interaction between warfighters and autonomous systems. - Continued studies to develop electrosence and biosonar for MOC and EOD missions - Continued development of improved recombinant antibodies for biothreat agents					
FY 2017 Plans: - Continue all efforts of FY 2016. - SYNTHETIC BIOLOGY FOR SENSING & ENERGY PRODUCTION: Initiate studies of scalability of microbial liquid fuel component production via electrobiosynthesis or bioreactor methodology.					
FY 2018 Base Plans: NAVAL BIOSCIENCE Continue research into the development of innovative naval biosensors, biomaterials, and bioprocess technology. Investigate engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks and AUV's. Conduct research on the development of microbial fuel cells for powering a linear sensor array. Study microbial electrochemical systems for shipboard desalination/waste-to-energy conversion and the closed-loop microbial fuels cells. Research explosive-sensing plants and microbial electrobiosynthesis of liquid fuels. Initiate development of micrpbial electronic devices. SYNTHETIC BIOLOGY FOR SENSING & ENERGY PRODUCTION Continue research on synthetic biology studies of engineered sentinel organisms for environmental surveillance. Initiate integration of programmable cellular controllers with robotic devices.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
LIFE SCIENCE AND BIOENGINEERING Continue marine mammal diagnostics efforts, including immunobioassays for stress and infection detection and efforts to detect, treat, and prevent diseases in dolphins, including diabetes and kidney stones. NEURAL, SENSORY AND BIOMECHANICAL SYSTEMS Continue efforts on naval biosensor to detect brain structures and blood vessels through skull bones. Investigate advanced biomimetic sensing and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems. Integrate biomimetic sonar with bioinspired autonomous undersea vehicles (with high-lift propulsors) to achieve closed loop control. Conduct research into bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on animal wing and fin biomechanics and in efforts of bio-inspired massively parallel vision systems. Study the development of brain-based intelligent systems to support high level interaction between warfighters and autonomous systems. Continue studies to develop electrosence and biosonar for MOC and EOD missions and the development of improved recombinant antibodies for biothreat agents. Materials and Chemistry Develop novel approaches to rapidly identify antibiotic resistant genes in bacterial pathogens of importance for the entire US military force. This effort will enable our transitional partners, the Naval Medical Research Center and the Naval Medical Research Laboratories, for rapid identification of highly resistant bacterial pathogens. ***FY 2018 OCO Plans:*** N/A					
Title: ENVIRONMENTAL QUALITY ***Description:*** Environmental Quality technologies enable sustained world-wide Navy operations in compliance with all local, state, regional, national and international laws, regulations and agreements. ***FY 2016 Accomplishments:*** - Continued development of new, advanced, environmentally benign Anti-Fouling (AF)/Anti-Corrosive (AC) coating systems for Navy platforms. - Continued development of advanced environmentally sound technologies for shipboard waste treatment and pollution abatement systems.	2.571	2.616	2.573	0.000	2.573

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued field evaluation of prototype robotic Hull BUG to identify gaps needed to refine and advance the technology for reduced drag, and significant fuel savings. - Continued studies on oil emulsion issues and development of novel bilge water treatment systems on existing and new ships. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017. - Complete studies on oil emulsion issues and development of novel bilge water treatment systems for existing and new ships ***FY 2018 OCO Plans:*** N/A					
Title: HUMAN FACTORS AND ORGANIZATIONAL DESIGN	5.015	5.063	5.159	0.000	5.159
Description: The overarching objective of this activity is the achievement of FORCEnet and Sea Power 21 goals by developing human factors principles and cognitive models for human centric design, decision support systems for collaborative decision making, and adaptive command and control structures. The CNO's Maritime Strategy and the Commander Fleet Forces Command complementary plan to revise organization of Maritime Operations Centers (MOC) place high priority on the aforementioned FORCEnet and Sea Power 21 goals. Specific objectives focus on improving small team, platform, task force, and battle group operations by developing advanced human factors technologies for incorporation into operational systems. The goals and payoffs are to enhance human performance effectiveness; improve the timeliness and quality of decision making; develop strategies to mitigate high workload and ambiguity; reduce manning; improve situational awareness and speed of command through a deeper understanding of human capabilities and limitations; and improvement of team decision making in ad-hoc, complex problem solving scenarios. ***FY 2016 Accomplishments:*** HUMAN COMPUTER INTERACTION/VISUALIZATION - Continued research on audio-visual cue integration for 360-degree periscope displays by utilizing eye-tracking, sleep studies and traditional behavioral measures to characterize human performance on periscope-related tasks under a variety of physiological conditions.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
COMMAND DECISION MAKING (CDM) - Continued to develop task management algorithms applicable to agile supervisory control of teams involving human and autonomous agents. - Continued development of information infrastructure that is operational context sensitive to allow the dynamic prioritization of date based on its anticipated information value and mission criticality. - Continued research building proactive decision support tools for Command and Control. - Initiated research for Navigating in Uncertainty. SOCIAL NETWORK ANALYSIS - Continued research on socio-technical aspects of community mobilization and complex humanitarian operations, including the use of novel platforms, social networks and the impact of novel technologies on human behavior in crisis and collaborative contexts. - Initiated development of testbeds and tool chains for rapid disaster analysis and response. - Initiated development of novel information feeds for Pacific Command.					
FY 2017 Plans: - Continue all efforts of FY 2016. - SOCIAL NETWORK ANALYSIS: - Initiate efforts on information conflicts, social-cyber behavior and hybrid warfare.					
FY 2018 Base Plans: HUMAN COMPUTER INTERACTION/VISUALIZATION Continue research on audio-visual cue integration for 360-degree periscope displays by utilizing eye-tracking, sleep studies and traditional behavioral measures to characterize human performance on periscope-related tasks under a variety of physiological conditions. COMMAND DECISION MAKING (CDM) Continue development of task management algorithms applicable to agile supervisory control of teams involving human and autonomous agents. Research the development of an information infrastructure that is operational context sensitive to allow the dynamic prioritization of date based on its anticipated information value and mission criticality. Study building proactive decision support tools for Command and Control. Investigate Navigating in Uncertainty. SOCIAL NETWORK ANALYSIS					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue research on socio-technical aspects of community mobilization and complex humanitarian operations, including the use of novel platforms, social networks and the impact of novel technologies on human behavior in crisis and collaborative contexts. Continue development of novel information feeds for Pacific Command and for testbeds and tool chains for rapid disaster analysis and response. Continue efforts on information conflicts, social-cyber behavior and hybrid warfare. Initiate research on competitive narrative and digital media assessment. ***FY 2018 OCO Plans:*** N/A					
Title: MEDICAL TECHNOLOGIES	5.709	6.392	6.465	0.000	6.465
Description: This program supports the development of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments; including regenerative medicine technologies and therapeutic/restorative practices for the treatment of combat-related traumatic injuries. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The National Institutes of Health (NIH) focuses on the basic science of disease processes and not applied research related to development. Programs are coordinated with other Services through the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee, and Joint Technical Coordinating Group (JTCG) process, to prevent duplication of effort. ***FY 2016 Accomplishments:*** UNDERSEA MEDICINE: - Continued efforts to reduce operational injuries - Continued studies on decompression sickness (DCS) and arterial gas embolism (AGE), to include novel approaches to the prevention, detection and treatment of DCS/AGE, particularly by nonrecompressive methods. - Continued efforts to develop prophylactic agents preventing hyperbaric oxygen toxicity. Prolonged exposure to hyperbaric oxygen can be toxic to lungs, nervous system and eyes. - Continued efforts to assess the impact of thermal (i.e., heat and cold) stress on operational performance. Underwater thermal extremes can affect diver performance and alter risk of incurring decompression sickness. - Continued studies related to optimization of diver performance. Operational performance in the undersea environment can be hampered by a variety of environmental stressors.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued studies related to optimization of submariner health and performance. Submarine crewmembers are exposed to a variety of unique stressors including prolonged deployments, effects of altered diurnal rhythms, non-standard breathing gases, lack of sunlight, etc. that can impact health and performance. - Continued research to explore novel pharmaceutical interventions for hyperbaric oxygen toxicity. - Continued research on resuscitation therapies for near-drowning victims. - Completed research into improved cognitive agility for divers and diving supervisors. - Completed research into diver human system integration - displays and biometric monitoring. REGENERATIVE MEDICINE: - Continued the program with the Armed Forces Institute for Regenerative Medicine (AFIRM). NOISE INDUCED HEARING LOSS (NIHL): - Continued research to reduce noise at the source, i.e. jet engine quieting and flight deck noise reduction. - Continued efforts to reverse NIHL. - Continued studies related to biomedical effects of underwater sound as military divers must operate safely and effectively in potentially complex underwater sound fields. - Continued efforts for "stress inoculation" to mitigate the impact of exposure to stressful combat environments prior to deployment. - Continued research to study the incidence, susceptibility, and mitigation strategies of NIHL and tinnitus. - Continued research in prevention and treatment of NIHL and tinnitus. - Continued research to improve personal protective equipment technology. - Continued Jet Noise Reduction Project to utilize analytical modeling and simulation tools anchored by experiment to develop and assess solutions enabling mitigation of jet induced noise from high performance tactical aircraft.					
FY 2017 Plans: - Continue all efforts of FY 2016, less noted as completed. - UNDERSEA MEDICINE: - Complete research on resuscitation therapies for near-drowning victims.					
FY 2018 Base Plans: UNDERSEA MEDICINE: Continue efforts to reduce operational injuries. Study decompression sickness (DCS) and arterial gas embolism (AGE), to include novel approaches to the prevention, detection and treatment of DCS/AGE, particularly by					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
nonrecompressive methods. Investigate the development of prophylactic agents preventing hyperbaric oxygen toxicity. Prolonged exposure to hyperbaric oxygen can be toxic to lungs, nervous system and eyes. Study the optimization of diver and submariner health and performance when exposed to a variety of environmental and unique stressors (heat and cold, prolonged deployments, effects of altered diurnal rhythms, non-standard breathing gases, lack of sunlight, etc). Explore novel pharmaceutical interventions for hyperbaric oxygen toxicity. . Initiate research on improving performance in extreme environments including integrated diving helmet audio-visual displays; human-machine symbiosis; nutrition, hydration and gut microbiome studies; and genomics/metabolomic approaches. REGENERATIVE MEDICINE: Continue the program with the Armed Forces Institute for Regenerative Medicine (AFIRM). NOISE INDUCED HEARING LOSS (NIHL): Continue research to reduce noise at the source, i.e. jet engine quieting and flight deck noise reduction. Study the biomedical effects of underwater sound as military divers must operate safely and effectively in potentially complex underwater sound fields. Mitigate the impact of exposure to stressful combat environments prior to deployment through "stress inoculation". Study the incidence, susceptibility, and mitigation strategies of NIHL and tinnitus. Research the prevention, treatment and reversal of NIHL and tinnitus. Investigate the improvement of personal protective equipment technology. Continue Jet Noise Reduction Project to utilize analytical modeling and simulation tools anchored by experiment to develop and assess solutions enabling mitigation of jet induced noise from high performance tactical aircraft. ***FY 2018 OCO Plans:*** N/A					
Title: THE OFFICE OF NAVAL RESEARCH GLOBAL ***Description:*** This PE supports the Office of Naval Research (ONR) Global mission to search the globe for emerging scientific research and advanced technologies to enable ONR and the Naval Research and Development Establishment (NR&DE) to effectively address the current needs of the Naval Fleet/Forces (F/F), and discover and assess revolutionary, high-payoff technologies for future Naval missions and capabilities. Within this Global mission, funding for the ONR Global Science Advisor Program ensures the F/F help shape the DON investment in science and technology (S&T), develops teaming relationships to rapidly demonstrate and transition technology, supports development of technology-based capability options for Naval Forces, and	11.614	12.235	12.757	0.000	12.757

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
enables warfighting innovations based on technical and conceptual possibilities. Science Advisors provide insight into issues associated with Naval Warfighting Capabilities that influence S&T program decision making. The program develops leaders among civilian scientists and engineers in the NR&DE. Upon completion of their tours, Science Advisors return to the NR&DE with firsthand knowledge of the how the USN/USMC conduct business, operational warfighting issues, and strategic decision making. The ONR Global Science Advisor Program enables continuous communication and collaboration between the warfighters, the technical community, and strategic development commands. ***FY 2016 Accomplishments:*** INTERNATIONAL SCIENCE PROGRAM Engaged with international scientists and engineers through more than 500 liaison visits to research institutions in more than 60 countries. ONR Global actively fostered international research collaboration by awarding 47 grants totaling $1.5M. Additionally, the command established the second office in South America, ONR Global Sao Paolo. SCIENCE ADVISORS ONR Global embedded twenty-four (24) Science Advisors into Naval Fleet/Force Commands worldwide to fulfill the role of Science and Technology (S&T) liaison for the principal, assist in current & future S&T requirements definition, and to provide US Sailors & Marines with near term technology solutions/capabilities. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. - Initiate the establishment of an ONR office in India. ***FY 2018 Base Plans:*** ONR Global will continue to support all Science Advisor program efforts and will continue to engage with the international S&T community through 28 PhD-level scientists, placed in seven overseas offices, utilizing liaison visits and awarding applied research grants. Complete the establishment of an office in India. ***FY 2018 OCO Plans:*** N/A					
Title: TRAINING TECHNOLOGIES ***Description:*** Training technologies enhance the Navy's ability to train effectively and affordably in classroom settings, in simulated environments, while deployed, and to operate effectively in the complex, high stress,	4.502	4.870	4.960	0.000	4.960

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
information-rich and ambiguous environments of modern warfare such as asymmetric warfare. Technology development responds to a variety of requirements, including providing more affordable approaches to training and skill maintenance. Improved training efficiency and cost-effectiveness is achieved by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the development, delivery, evaluation, and execution of training. ***FY 2016 Accomplishments:*** COGNITIVE SCIENCE OF LEARNING - Continued research and assessment of advanced gaming technology for enhanced training. - Continued creation and conduct of experiments to validate automated performance assessment and after action reviews. - Continued a systematic program of applied research addressing unanswered questions regarding effective instructional strategies in artificially intelligent tutoring. - Continued research in the neuro-biology of learning including integration of the role of white matter - Continued development of games that incorporate AI techniques to teach complex warfighter skills decision-making and problem solving. - Continued development of intelligent avatars to interact with learners from different cultural, linguistic backgrounds, and preferences. - Continued development of scenarios generators that produce integrated training (e.g., individual and collective) training. - Continued development of optimal training strategies for intelligent jobs on mobile devices (e.g., IPad). - Continued development of immersive environments for training interpersonal and leadership skills. - Continued design and conduct experiment to assess training effectiveness of intelligent tutor for training ship handling skills. - Continued development of novel psychometric approaches to assess human performance in medical/ military simulations and simulators. - Continued research in design features of medical and military simulators and simulations. - Continued field studies and user tests evaluating new features and job aiding tools. - Continued research into computational neuron-models in the design of training systems. ENHANCING WARFIGHTER COGNITIVE CAPABILITY:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research to understand the structural relations among the latent variables of short-term memory, working memory, executive attentional control, and fluid intelligence. - Continued research to assess the improvement in recruit classification provided by the addition of measures of fluid intelligence and working memory. - Continued research to understand the role of intrinsic motivation in facilitating the transfer of working memory training to other cognitive capabilities. - Continued research to assess the efficacy of game-based brain training using hand-held (fieldable) hardware platforms. - Continued research to determine the relationship between induced gains in fluid intelligence and cognitive adaptability and agility, considered from the perspective of military decision-making. - Continued task to develop multi-agent based architectures for modeling human behavior, improve techniques for human cognitive and behavioral modeling, and create highly realistic simulated teammates. COMPUTATIONAL MODELS OF HUMAN BEHAVIOR: - Continued research into game based training to more effectively enable better warfighter understanding of languages and cultures to enhance their regional expertise - Continued research on software tools to facilitate building natural language tutorial dialogs for artificially intelligent tutoring. - Continued the integration of cognitive and neuron-computational models of human learning					
FY 2017 Plans: - Continue all efforts of FY 2016.					
FY 2018 Base Plans: COGNITIVE SCIENCE OF LEARNING Research and assess advanced gaming technology for enhanced training. Conduct experiments to validate automated performance assessment and after action reviews. Develop a systematic program of applied research addressing unanswered questions regarding effective instructional strategies in artificially intelligent tutoring. Research the neuro-biology of learning including integration of the role of white matter. Develop games that incorporate artificial intelligence (AI) techniques to teach complex warfighter skills decision-making and problem solving. Develop optimal training strategies for intelligent jobs on mobile devices (e.g., IPad) and immersive environments for training interpersonal and leadership skills. Design and conduct experiment to assess training effectiveness of intelligent tutor for training ship handling skills. Design features and develop novel psychometric approaches to assess human performance in medical/ military simulations and simulators.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Conduct field studies and user tests evaluating new features and job aiding tools. Research computational neuron-models in the design of training systems. Develop skill decay models for psychomotor, perceptual, and cognitive skills and refresher training strategies. Create intelligent avatars to interact with learners from different cultural, linguistic backgrounds, and preferences. Design scenarios generators that produce integrated (e.g., individual and collective) training. Initiate development of computational model for learning theory to drive design of instruction and continue research on individual differences. ENHANCING WARFIGHTER COGNITIVE CAPABILITY: Continue research to understand the structural relations among the latent variables of short-term memory, working memory, executive attentional control, and fluid intelligence. Assess the improvement in recruit classification provided by the addition of measures of fluid intelligence and working memory. Understand the role of intrinsic motivation in facilitating the transfer of working memory training to other cognitive capabilities. Study the efficacy of game-based brain training using hand-held (fieldable) hardware platforms. Determine the relationship between induced gains in fluid intelligence and cognitive adaptability and agility, considered from the perspective of military decision-making. Develop multi-agent based architectures for modeling human behavior, improve techniques for human cognitive and behavioral modeling, and create highly realistic simulated teammates. COMPUTATIONAL MODELS OF HUMAN BEHAVIOR: Research game based training to more effectively enable better warfighter understanding of languages and cultures to enhance their regional expertise. Develop software tools to facilitate building natural language tutorial dialogs for artificially intelligent tutoring. Integrate cognitive and neuron-computational models of human learning. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	44.092	45.467	48.649	0.000	48.649

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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D. Acquisition Strategy

N/A

E. Performance Metrics

As discussed in Section A, there are a significant number of varied efforts within this PE. Each effort is measured against both technical and financial milestones. Each program effort and its projects are reviewed in depth for technical and transition performance against established goals. The Program Managers conduct routine site visits to performing organizations to assess programmatic and technical progress and most projects conduct an annual or biannual review by an independent board of visitors who assess the level and quality of the Science and Technology (S&T) basis for the project.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602271N *I Electromagnetic Systems Applied Research*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	116.362	118.941	79.598	-	79.598	80.951	78.954	78.715	80.288	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	0.000	116.362	118.941	79.598	-	79.598	80.951	78.954	78.715	80.288	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan, approved by the S&T Corporate Board (20 January 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

The Electromagnetic Systems Applied Research Program addresses technology needs associated with Naval platforms for new capabilities in EO/IR Sensors, Surveillance, Electronic Warfare, Navigation, Solid State Electronics, Vacuum Electronics Power Amplifiers, and Nanoelectronics. The program supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection, Time Critical Strike, and Information Distribution. This program directly supports the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Activities and efforts within this Program have attributes that focus on enhancing the affordability of warfighting systems. The program also provides for technology efforts to maintain proactive connectivity and collaboration between Department of the Navy (DON) Science and Technology (S&T) and Joint, Navy, and Marine Corps commands worldwide.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	114.644	118.941	132.104	-	132.104
Current President's Budget	116.362	118.941	79.598	-	79.598
Total Adjustments	1.718	0.000	-52.506	-	-52.506
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	4.157	0.000			
• SBIR/STTR Transfer	-2.439	0.000			
• Program Adjustments	0.000	0.000	-52.506	-	-52.506

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602271N *I Electromagnetic Systems Applied Research*			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

The funding decrease in FY 2018 reflects the realignment of the innovative naval prototypes Electronic Maneuver Warfare Command & Control (EMC2) and NEMESIS into the new Innovative Naval Prototypes (INP) Applied Research PE 0602792N.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
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COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Electromagnetic Systems Applied Research*	0.000	116.362	118.941	79.598	-	79.598	80.951	78.954	78.715	80.288	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project addresses technology opportunities associated with Naval platforms for new capabilities in EO/IR Sensors, Surveillance, Electronic Warfare, Navigation, Solid State Electronics, Vacuum Electronics Power Amplifiers, and Nanoelectronics. The project supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection, Time Critical Strike, and Information Distribution. This project directly supports the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Activities and efforts within this program have attributes that focus on enhancing the affordability of warfighting systems. The program also provides for technology efforts to maintain proactive connectivity and collaboration between Department of the Navy (DON) Science and Technology (S&T) and Joint, Navy, and Marine Corps commands worldwide.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: ELECTRONIC WARFARE TECHNOLOGY	72.742	70.269	44.008	0.000	44.008
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Electronic Warfare (EW) systems across the entire electromagnetic spectrum (EMS) that will increase the operational effectiveness and survivability of U.S. Naval units. Emphasis is placed on passive sensors and active and passive countermeasure (CM) systems that exploit and counter a broad range of electromagnetic threats. The focus is on maintaining near perfect, real-time knowledge of the enemy; countering the threat of missiles against deployed Naval forces; precision identification and location of threat emitters; and development of technologies that have broad application across multiple disciplines within the EW mission area. This activity also includes developments to protect these technologies from external interference, and modeling and simulation required to support the development of these technologies. Also included is technology development in support of the Integrated Distributed Electronic Warfare System (IDEWS) concept. The objectives reported in prior years under this R-2 Activity have been consolidated into the current objectives described below. The current objectives are:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- EW RF Technology: Develop and demonstrate technologies in the Radio Frequency (RF) spectrum (covering frequencies from kilohertz to terahertz) that include developments in detection, signal processing and passive/ active techniques for wideband Electronic Attack (EA), Electronic Protection (EP) and the Electronic Support (ES) mission areas. - EW EO/IR Technology: Develop and demonstrate technologies in the Electro-Optic and Infrared (EO/IR) spectral domain (extending from the ultraviolet to the far infrared spectral bands) that include advances in multispectral sensors, multiband sources, beam forming/steering, and signal processing and transmission. - EW Integrated and Networked Technology: Develop and demonstrate technologies that will enable an increased situational awareness and response across the electromagnetic spectrum (EMS) with broad spatial coverage using all available EW assets to provide coordinated, adaptive and networked EW sensing, protection and attack. - Advanced EW Enabling Technologies: Develop classified advanced electronic warfare technology in support of current and predicted capability requirements. - Electromagnetic Maneuver Warfare Command & Control (EMC2) (FY16-FY20): Enable a battle group to work cooperatively in the EM Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), Communications (Comms) and Radar performance. EMC2 will build upon the Resource Allocation Manager (RAM) that was previously developed for single multifunction systems under the InTop program to optimize spectrum and functional use across a platform and an entire battle group. Decrease in funding from FY 2017 to FY 2018 is due to: - Completion of exploratory research into advanced technologies to counter emerging threats operating in higher bands of the radio frequency spectrum utilizing extreme spectral and temporal agility. - Starting in FY 2018, all Innovative Naval Prototype (INP) and Leap Ahead Technology (LA-Tech) investments in Electromagnetic Maneuver Command & Control (EMC2) Warfare will be shown in the new INP PE 0602792N Innovative Naval Prototypes (INP) Applied Research to better convey exactly what the Office of Naval Research is working on in this area.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** EW RF Technology: - Continued development of a monolithic optical chip set capable of multi-function radio-frequency signal processing for electronic warfare (EW) applications. - Continued development of technology to improve transmit/receive isolation by properly controlling surface currents with engineered materials. - Continued development of a millimeter wave Rotman Lens-based electronic attack transmitter. - Continued technology development in transmit-to-receive isolation technologies and techniques, relevant to the spectral range of 1 to 110 GHz. - Continued the development of Sub-System Demonstrators (SSDs) leveraging wideband radio frequency (RF) components and sub-systems from prior DoD investments to demonstrate advanced electronic warfare support (ES) and electronic attack (EA) capabilities covering a broad range of RF frequencies in support of Navy and Marine Corps mission areas. - Continued development of Infrared Gradient Index optics and associated SWaP advantages for multispectral imagers in a prototype system. - Completed the development of photonic techniques for broadband electronic surveillance systems. - Completed the development of innovative high date-rate protected communications to circumvent malicious cyber-attack (Project Calliope) EW EO/IR Technology: - Completed development of semiconductor-based, multi-wavelength integrated laser sources spanning multiple bands of the ultraviolet, visible, near infrared (IR), mid-wave IR, and long-wave IR. EW Integrated and Networked Technology: - Continued technologies that develop new methods to represent real-time dynamic spectrum knowledge, sense and learn signal characteristics and behaviors, and to reason about threat systems and the environment to form EA strategies on-the-fly. - Continued technologies that develop extremely high-volume processing capabilities for reconfigurable EW systems. - Continued development of fast signal classification of coherent radar signals for use in chanelized digital transceiver systems to support rapid countermeasure response.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed development of a Bayesian statistical framework paired with a novel stochastic algorithm to support EW probability of raid annihilation analysis. Advanced EW Enabling Technologies (Formerly Titled: Electronic Warfare (EW) Roadmap): - Continued development of classified, advanced, electronic warfare technology in support of current and predicted capability requirements. Electromagnetic Maneuver Warfare Command & Control (EMC2): - Initiated Wideband Airborne Multifunction System design - Initiated Low Band RF Intelligent Distributed Resource (LowRIDR) SubSystem build - Initiated Electromagnetic Warfare Command and Control system design ***FY 2017 Plans:*** EW RF Technology - Continue all efforts of FY 2016 less those noted completed above. EW EO/IR Technology: - Continue all efforts of FY 2016 less those noted completed above. - Initiate the development of SSDs leveraging multiband EO/IR components and sub-systems from prior DoD investments to demonstrate advanced ES and EA capabilities covering a broad range of EO/IR wavelengths in support of Navy and Marine Corps mission areas. EW Integrated and Networked Technology - Continue all efforts of FY 2016 less those noted completed above. - Complete development of fast signal classification of coherent radar signals for use in chanelized digital transceiver systems to support rapid countermeasure response. Electromagnetic Maneuver Warfare Command & Control (EMC2): - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** The Electromagnetic Warfare applied research being conducted includes efforts in both RF countermeasures and EO/IR Countermeasure including both detection and defeat. Technology developments to provide capabilities indigenous to small UASs are a significant focus. Technology developments being addressed					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
include laser based IR countermeasures, non-mechanical holographic means for optical beam steering for EO/IR countermeasures, the development of new optical lens technologies based on gradient indexed (GRIN) optics. This latter technology when coupled with another ongoing effort in multidimensional optics show significant promise for greatly reducing the weight of highly capable optical systems. Additionally there is a focus on developing the high payoff technology of chip scaled integration of optical photonic components with microwave components. Technology is being investigated to determine the potential for being able to conduct specific emitter identification and classification relative to gun blasts using IR imagers. RF efforts include work in developing engineered high transmit to receiver materials for significant improvements in isolation. Work is ongoing to expand EW jamming capabilities at high power levels covering previously unaddressed frequency bands with significant operational impact. The technologies to permit operations of EW attack in friendly communications bands without attendant fratricide is being researched using alternative technology approaches over current approaches. Cognitive electronic attack approaches in both the communications bands and radar bands are ongoing to address the need to address and defeat unidentified RF pop-up threats. Results have been obtained in ongoing research in metamaterials in the RF domain. Completed development of Infrared Gradient Index optics and associated SWaP advantages for multispectral imagers in a prototype system. ***FY 2018 OCO Plans:*** N/A					
Title: EO/IR SENSOR TECHNOLOGIES	5.913	5.314	7.078	0.000	7.078
Description: The overarching objective of this thrust is to develop technologies that enable the development of affordable, wide area, persistent surveillance optical architectures, day/night/adverse weather, adaptable, multi-mission sensor technology comprised of optical sources, detectors, and signal processing components for search, detect, track, classify, identify (ID), intent determination, and targeting applications and includes developments to protect these technologies from external interference. Also included are modeling and simulation required to support the development of these technologies. Efforts will also include the development of optical RF components, infrared technologies including lasers and focal plane arrays using narrow bandgap semiconductors. The current specific objectives are: a) Optically Based Terahertz (THz) and Millimeter Wave (MMW) Distributed Aperture Systems:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Develop optically based terahertz (THz) and millimeter wave distributed aperture systems for imaging through clouds, fog, haze and dust on air platforms. b) Wide Area Optical Architectures: Develop wide area optical architectures for persistent surveillance for severely size constrained airborne applications. c) Hyperspectral sensors and processing: Develop visible, shortwave IR, mid-wave IR, and long-wave IR hyperspectral sensors, along with processing algorithms to detect anomalies and targets. d) Coherent Laser Radar (LADAR): Develop and improve components for LADAR applications including fiber lasers, coherent focal planes, and advanced processing. e) Autonomous and Networked sensing: Develop algorithms and processing that supports autonomous sensing for UAV platforms and that supports networked sensing over multiple sensors and/or sensor platforms. The funding increase from FY2017 to FY2018 is due initiation of efforts to develop and test a short-wave infrared (SWIR) multispectral LIDAR system capable of simultaneous 4D spatial-spectral information for imaging and spectral discrimination through obscurations, and to develop wide field of view EO/IR Counter-measures to detect, track and/or jam sensors. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Optically Based Terahertz (THz) and Millimeter Wave Distributed Aperture Systems: - Continued development of a robust imaging capability to provide situational awareness in brownout conditions during takeoff/landing operations in desert environments. - Continued miniaturization and modularization of Millimeter Wave (MMW) imaging system components for small platform systems. - Continued progressing the integration of spectrally agile multi-band sensors into integrated system for use in persistent and time critical surveillance.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued progressing the processing architecture for data analysis and fusion of multi-spectral images. - Continued development of range-gated image reconstruction using optical phase conjugation. - Completed the development of range-gated image reconstruction using optical phase conjugation. (FY16) Wide Area Optical Architectures: - Continued development of mid and long wave infrared (IR) focal plane arrays (FPAs) using graded-bandgap, Wtype-II, superlattices with much higher detectivity than state-of-the-art Mercury Cadmium Telluride (HgCdTe,MCT) FPAs. - Continued design of read-out integrated circuits for temporally adaptive focal plane arrays. - Continued development of spectrally agile visible, near-infrared, short-wave infrared and midwave infrared imaging technology. - Continued development of super-resolution techniques in Wide Field of View Mid-Wave Infrared (WFOV MWIR) sensors. - Continued effort to develop components, study and demonstrate optical links that allow quantum key distribution (QKD) through free space using modulating retro-reflectors (MRRs). Hyperspectral sensors and processing: - Continued integration of hyperspectral instruments onto test platforms. - Continued processing of hyperspectral data from a maritime environment. - Completed effort to develop mid-wave infrared focal plane arrays using plasmonically coupled antimonide based majority carrier barrier device structures on advanced digital readouts for ultra low size, weight, and power night-time wide area surveillance. Coherent Laser Radar (LADAR): - Continued development of fiber lasers and coherent focal plane arrays suitable for LADAR applications. - Completed fabrication and modeling of silicon photonic chips for one dimensional beam steering. - Completed effort to develop fiber-based long wave infrared agile, narrow-band and broadband laser sources for sensing and counter measure applications. Autonomous and Networked sensing: - Continued development of algorithms and processing that supports autonomous sensing for UAV platforms					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of algorithms and processing that supports networked sensing over multiple sensors and/or sensor platforms. ***FY 2017 Plans:*** Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems: - Complete development of a robust imaging capability to provide situational awareness in brownout conditions during takeoff/landing operations in desert environments. - Complete miniaturization and modularization of MMW imaging system components for small platform systems. - Complete progressing the integration of spectrally agile multi-band sensors into integrated system for use in persistent and time critical surveillance. - Complete progressing the processing architecture for data analysis and fusion of multi-spectral images. Wide Area Optical Architectures: - Continue all efforts of FY 2016 less those noted as complete above. Hyperspectral sensors and processing: - Continue all efforts of FY 2016 less those noted as complete above. Coherent Laser Radar (LADAR): - Continue all efforts of FY 2016 less those noted as complete above. Autonomous and Networked sensing: - Continue all effort of FY 2016. - Initiate development of multi-mode (spectral, polarization, temporal) imaging sensors for detecting low observable targets and for imaging through degraded visual environments. - Initiate development of extremely sensitive mmW detector technology. ***FY 2018 Base Plans:*** Electromagnetic Warfare work is ongoing to address the critical deficiency with respect to operations in brownout conditions. IR and terahertz technologies are being modified and integrated with the expectations that combining these two technologies an effective solution can be obtained. Bistatic radar and imaging technology is being developed to extend surveillance capabilities and passively engage targets. A unique approach permitting rapid active scanning of a battlefield in the IR domain using a non-mechanically scanned mechanism is under development. This technology if successful will eliminate the multiple laser ball systems currently					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
required to accomplish this same requirement at lower SWAP. Active work is also being focused on developing capabilities for high resolution, wide field of view sensors on modest sized UAS platforms. Research advanced materials and chemistry fabrication methods to develop micro-retro-reflectors operating in short wavelength IR systems. This study is directed to develop unique spectral bar codes. Major accomplishments include development of high refractive index glass composition. Create and explore new electronics concepts, components, techniques, and subsystems for the generation, and transmission of UV, visible, and infrared radiation to support current and future Navy and DoD needs. Continue research in optical components and infrared technologies including lasers and focal plane arrays using narrow bandgap semiconductors for the purpose of imaging through clouds, fog, haze and dust; persistent surveillance for severely size constrained airborne applications; detecting anomalies and targets; and autonomous sensing for UAV platforms and networked sensing over multiple sensors and/or sensor platforms. Complete effort to develop components, study and demonstrate optical links that allow quantum key distribution (QKD) through free space using modulating retro-reflectors (MRRs). Complete effort to develop a novel IR focal plane bolometric sensor based upon graphene electronic materials. ***FY 2018 OCO Plans:*** N/A					
Title: NAVIGATION TECHNOLOGY	4.451	7.281	6.120	0.000	6.120
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Position, Navigation and Timing (PNT) capabilities using the GPS, non-GPS navigation devices, and atomic clocks. This project will increase the operational effectiveness of U.S. Naval units. Emphasis is placed on GPS Anti-Jam (AJ) Technology; Precision Time and Time Transfer Technology; and Non-GPS Navigation Technology (Inertial aviation system, bathymetry, gravity and magnetic navigation). The focus is on the mitigation of GPS electronic threats, the development of atomic clocks that possess unique long-term stability and precision, and the development of compact, low-cost Inertial Navigation Systems (INS). The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The increase from FY 2016 to FY 2017 is due to increased funding for the Navigation and Precision Timekeeping initiative. The decrease in funding from FY 2017 to FY 2018 is due to the ramp down of the Navigation and Precision Timekeeping initiative. ***FY 2016 Accomplishments:*** GPS Anti-Jam Antennas and Receivers: - Continued development of Military User Equipment Integrated Fault Analysis effort. - Continued and completed Anti-tamper Investigation Support. - Continued and completed System for enhanced electronic protection, electronic support and precision navigation. - Completed Cognitive MGUE with Chaotic Timing Signals for GPS Denied Environments. - Completed Precise at-Sea Ship System for Indoor Outdoor Navigation (PASSION) project. Precision Time and Time Transfer Technology: - Continued Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project. - Continued developing Advanced-Development of a Miniature Atomic Clock. - Continued analysis of Code Distortion in Modernized GPS Signals on GPS Timing Receiver. - Continued development of Compact and Versatile Passively CEP (carrier envelope phase) Stabilized Optical Clock system. - Initiated Precision Optical Clock Technology Development Non-GPS Navigation Technology: - Initiated Cold Atom Inertial Navigation System (INS) Sensor Technology Development. - Continued Optically Transduced INS Sensor Suite (OPTIMUSS) project. - Continued development of the Three-Axis Resonant Fiber Optic-based Inertial Navigation System with the accuracy of 10 milli(m)-degrees per hour and the angle random walk (ARW) of 10 milli (m)-degrees per root hour. - Continued development of Micro-Electro-Mechanical System (MEMS) Gyro effort. - Completed Embedded Sonar Aided Inertial Navigation Technology (SAINT) project. ***FY 2017 Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
GPS Anti-Jam Antennas and Receivers: - Complete development of Military User Equipment Integrated Fault Analysis effort. - Initiate at multi-constellation GPS receiver effort for high anti-jam and anti-spoof with wideband frontend. - Initiate research in application of advanced processing methods for robust GPS operation in challenged environments. Precision Time and Time Transfer Technology: - Continue all efforts of FY 2016. - Continued analysis of Code Distortion in Modernized GPS Signals on GPS Timing Receiver. - Continued developing Advanced-Development of a Miniature Atomic Clock. - Complete development of Compact and Versatile Passively CEP (carrier envelope phase) Stabilized Optical Clock system. - Complete Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project. - Initiate Optical Clock development efforts for compact, deployable next generation clock technology to greatly surpass current Rubidium and Cesium standards, providing the ultimate in time holdover in GPS denied environments. - Initiate RF and Optical time transfer effort for terrestrial, surface, and airborne platforms. Non-GPS Navigation Technology: - Continue all efforts of FY 2016. - Complete Optically Transduced Inertial Navigation System (INS) Sensor Suite (OPTIMUSS) project. - Complete development of Micro-Electro-Mechanical System (MEMS) Gyro effort. - Complete MEMS Inertial Navigation System Phase II project. - Initiate hybrid velocity measuring sonar system for compact underwater and surface platforms. - Initiate development of a thermal or cold atom beam 3 axis navigator. - Initiate investigation of compact indexed inertial for airborne, weapon, or unmanned UUV platforms. ***FY 2018 Base Plans:*** Continue applied research in position, navigation and timing. This research aims to develop techniques and technology to provide assured, cost-effective, and mission relevant PNT to the warfighter. Areas of investment included robust GPS, non-GPS navigation aids, and assured timekeeping. Specifically, GPS Anti-Jam Antennas and Receivers for Navy platforms for the purpose of providing precision navigation capabilities in the presence of electronic threats and anti-spoofer/anti-jam processors for the purpose of providing precision navigation					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
capabilities in the presence of emergent threats; Tactical grade atomic clocks that possess unique long-term stability and precision for the purpose of providing GPS-independent precision time and transferring GPS-derived time via radio frequency links for the purpose of providing GPS-independent precision time; and Inertial navigation systems for the purpose of providing an alternative means of providing precision navigation, a correlation navigation technique using earth maps of high precision, for those Naval platforms which may not have GPS navigation capabilities and/or loss of GPS signals. ***FY 2018 OCO Plans:*** N/A					
Title: SOLID STATE ELECTRONICS ***Description:*** The overarching objective of this activity is to develop higher performance components and subsystems for all classes of military RF systems that are based on solid state physics phenomena and are enabled by improved understanding of these phenomena, new circuit design concepts and devices, and improvements in the properties of electronic materials. An important subclass are the very high frequency (VHF), ultra-high frequency (UHF), microwave (MW), and millimeter wave (MMW) power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapon systems. Another subclass are the analog and high speed, mixed signal components that connect the electromagnetic signal environment into and out of digitally realized, specific function systems. These improved components are based on both silicon (Si) and compound semiconductors (especially the wide bandgap materials and narrow bandgap materials), low and high temperature superconductors, novel nanometer scale structures and materials. Components addressed by this activity emphasize the MMW and submillimeter wave (SMMW) regions with an increasing emphasis on devices capable of operating in the range from 50 gigahertz (GHz) to 10 terahertz (THz). The functionality of the technology developed cannot be obtained through Commercial-Off-the-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, operational and instantaneous bandwidth, weight, and size. Effort will involve understanding the properties of engineered semiconductors as they apply to quantum information science and technology. This activity also includes Anti-Tamper development of innovative techniques and technologies to deter the reverse engineering and exploitation of our military's critical technology and critical program information in order to impede technology transfer and alteration of system capability and prevent the development of countermeasures to U.S. systems. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.	9.923	12.856	11.040	0.000	11.040

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The increase from FY 2016 to FY 2017 is due to increased funding for the Electromagnetic Applied Research initiative. The decrease from FY 2017 to FY 2018 is due to a ramp down in funding towards the Anti-Tamper Program. ***FY 2016 Accomplishments:*** Solid State Transistors and Devices: - Initiated development of ultra-efficient mm-wave transistors. - Continued effort to develop and exploit reduced dimensionality transistors. - Continued effort to develop a high performance graphene base hot electron transistor. - Continued development of an integrated, tunable, frequency selective and low noise integrated module. - Continued effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. - Continued MMW field plate GaN High Electron Mobility Transistor (HEMT) development. - Continued progressing mixed-signal GaN Monolithic Microwave Integrated Circuit (MMIC) technology development. - Continued investigations into ultra-low noise, Group III-Nitride, transistor structures for RF and mm-wave receivers and transmitters. - Continued group III-Nitride transistor development for 1 THz circuits. - Continued development of discrete, channelized, Gallium Nitride Transistors for linear and low noise transmit and receive amplifiers. - Completed effort to develop ultra-scaled AlN/GaN transistors to enable superior RF amplifier performance in G-band applications. High Efficiency, Highly Linear Amplifiers: - Initiated research into harmonic mm-wave amplifiers - Continued effort to develop transmit and receive components using reduced dimensionality transistors. - Continued development of MMW AlGaN/GaN wide bandgap HEMT. - Continued development of AlGaN HEMT broadband amplifiers for electronic warfare decoys with increased power and efficiency than achieved with conventional solid state amplifiers. - Continued high-efficiency microwave GaN HEMT amplifier development.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued work on GaN MMW components at >44 GHz to allow for EHF SATCOM insertion and other MMW applications spanning to 95GHz. - Continued expansion of scope of the GaN MMW device program. - Continued and demonstrate Low-Noise, High Dynamic Range Receiver Chain for Simultaneous Transmit and Receive (STAR) Applications. - Continued component development in support of multifunctional electronic warfare. - Continued transition of GaN high-efficiency microwave HEMT amplifiers to radar and communications applications. - Continued development of MMW high efficiency amplifiers for satellite communications and compact high efficiency MMW sources for active denial systems. - Continued development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications. - Continued Sub-MMW GaN Device technology for communications, target identification and high speed data processing. - Continued development of GaN Monolithic Microwave Integrated Circuit (MMIC) Amplifier Technology for operation greater than (>)100 GHz. - Continued development of high efficiency GaN amplifier MMICs for 50-100 GHz operation. - Continued low-noise, high dynamic range Group-III Nitride amplifier development for W-band receivers. - Continued development of group III-Nitride amplifiers for terahertz amplification. - Continued development of high power density, high output power, solid state mm-wave amplifiers. Superconducting Electronics: - Continued effort to develop reprogrammable superconducting digital filters capable of limiting Instantaneous Bandwidth (IBW) of output data stream from Analog-to-Digital Converter (ADC) to user defined choices and doing this with >10X lower processing latency and energy cost than possible in room temperature circuits. - Continued effort to design of Analog-to-Digital Converters (ADC) to enhance minimum detectable signal sensitivity levels by 10 dB. - Continued development of effort to improve superconducting analog to digital converter performance by more than 2 bits as well as 2x in sample rate. - Continued research on components needed to achieve improved interference immunity. - Continued heterogeneous component technology development to enable performance enhancement of analog-digital converters and ultra-wideband receivers and transmitters. Control, Reception, Transmission, and Processing of Signals:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued efforts to develop compact, high performance switch, filter, and high isolation device technologies for agile, broadband signal processing in cluttered environments. - Continued development of Gallium Nitride-based low-noise components for Interference Immune Navy Satcom receivers. - Continued investigations into low-noise, high dynamic range group-III Nitride receiver components for W-band and higher signal detection. - Continued development of group III-Nitride terahertz receive technologies. - Continued work on multi-THz real-time signal processing using combination of high speed electronic, photonic, and metamaterial techniques. - Continued research into affordable digital array, interfacing technologies using low power, mixed signal approaches, wafer scale antennas, and analog photonic transmission techniques. - Continued research into compact, broadband filter and channelizer components targeting multi-octave operation in the range from VHF to W-band. - Completed effort to develop micro-miniature ferroelectrically active tunable acoustic wave devices for fast reconfiguration of circuits and systems operating at microwave through sub-millimeter-wave frequencies. - Continued RF electronics and photonics development to implement wideband Simultaneous Transmit and Receive sensing and communications apertures on disadvantaged platforms. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continued developing new research in graphene synthesis and device concepts. - Continued work on graphene based devices and circuits for low power flexible electronics. - Continued research on graphene-organic hybrid materials interfaces and device structures. - Continued large-scale hexagonal boron nitride (hBN) synthesis as substrate for graphene and other 2D materials. Anti-Tamper: - Continued efforts to develop physically unclonable functions and high density 3D packaging technologies. - Continued efforts to develop destruct mechanisms that do not cause collateral damage. - Continued efforts to develop advanced sensors and coatings.					
FY 2017 Plans: Solid State Transistors and Devices: - Continue all efforts of FY 2016 less those noted as completed above.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate development of highly linear source electric field engineered HEMT devices. - Initiate development of ultra-efficient nitrogen-polar mm-wave transistors. - Initiate Electromagnetic Applied Research initiative. High Efficiency, Highly Linear Amplifiers: - Continue all efforts of FY 2016 less those noted as completed above. - Complete and demonstrate Low-Noise, High Dynamic Range Receiver Chain for Simultaneous Transmit and Receive (STAR) Applications. - Initiate high output impedance RF amplifier development for photonically-enabled STAR architectures. Superconducting Electronics: - Continue all efforts of FY 2016 less those noted as completed above. - Initiate realization of RF mixed signal components predicted to have significantly improved performance using newly available switching devices. Control, Reception, Transmission, and Processing of Signals: - Continue all efforts of FY 2016 less those noted as completed above. - Initiate development of high RF impedance electro-optic modulators for photonically-enabled STAR architectures. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continue all efforts of FY 2016. Anti-Tamper: - Continue all efforts of FY 2016 less those noted as completed above. ***FY 2018 Base Plans:*** Continue research in the areas of solid state transistors and devices for high frequency analog and digital operation; high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications; superconducting and other technologies which are designed to deliver software defined, wide band, many simultaneous signal functionality over a wide range of frequencies, in increasingly field-ready packaging and demonstrate the ability of these components to deliver superior functionality in conventional system contexts, including, but not limited to, SATCOM, Surveillance Electronic Warfare (EW), signal intelligence					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
(SIGINT), and communications; electronics and photonics technology that provides for the control, reception, transmission and processing of signals; and Anti-Tamper: develop a undetectable, robust, low/no power, low cost set of technologies that can be deployed in many different systems from many different vendors for the purpose of protecting critical technology and critical program information contained in U.S. military systems from tampering and reverse engineering. Conduct exploratory research to develop electronic materials, devices, components, and circuits in the frequency range of ~ 1 MHz to ~ 10 THz that provide system performance edge compared to COTS-based solid state electronics to ensure supremacy of future radar, EW, communications, sensor, and intelligence systems. ***FY 2018 OCO Plans:*** N/A					
Title: SURVEILLANCE TECHNOLOGY ***Description:*** The overarching objective of this activity is to develop advanced sensor and sensor processing systems for continuous, high volume, theater-wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection and discrimination, target identification (ID) and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments and includes modeling and simulation required to support the development of these technologies. The current specific objectives are: a) Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: Develop radar architectures, sensors, and software which address Ballistic Missile and Littoral requirement shortfalls including: sensitivity; clutter rejection; and flexible energy management. b) Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration and Feature Extraction: Develop algorithms, sensor hardware, and signal processing techniques for automated radar based contact mensuration and feature extraction in support of asymmetric threat classification and persistent surveillance and to address naval radar performance shortfalls caused by: man-made jamming and Electronic Counter Measures (ECM), unfavorable maritime conditions, and atmospheric and ionosphere propagation effects.	10.869	9.749	8.998	0.000	8.998

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
c) Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: Develop software, and hardware for a multi-platform, multi-sensor surveillance system for extended situational awareness of the battlespace. d) Small UAV Collision Avoidance/Autonomy Technology: Develop small UAV collision avoidance/autonomy technology. e) Long Range Radio Frequency (RF) Identification (ID): Develop, hardware, software, algorithms, and RF techniques to extend identification capabilities in support of Intelligence Surveillance and Reconnaissance (ISR). Funding decrease from FY16 to FY17 is a result of the completion of algorithm, sensor, and signal activities. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continued Advanced Common Radar Architecture and mode development. - Continued High Power, High Duty Factor, X-band Amplifier Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction: - Continued demonstrations of advanced Non-Cooperative Target Recognition (NCTR) algorithms in congested harbor environments. - Continued development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenged environments. - Continued investigation of means of optimally combining mensuration, classification, and noncooperative target recognition of surface craft. - Continued development of a technology architecture for the Persistent Autonomous Surveillance System. - Continued development of automated controls for an airborne persistent multi-node sensor network. - Continued progressing development of algorithms and signal processing for Electronic Protection in airborne radars.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued progressing development of software and algorithms for multi-platform radar controls. - Completed development of a technique to measure motion with a multi-aperture synthetic aperture radar. - Completed development of amplitude control of radar transmit waveforms. - Completed development of design and full-wave characterization of phased-array systems using the domain decomposition-finite element method. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continued development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment. - Continued modeling and simulation of shipboard and airborne RF networked sensors to characterize their performance in a challenge environment. - Continued field measurement to characterize coherent and non-coherent position, navigation, timing and communications requirements. Small UAV Collision Avoidance/Autonomy Technology: - Continued development of research technologies and analytical algorithms for an effective and highly reliable collision avoidance system. Long Range Radio Frequency (RF) Identification (ID): - Continued studies for Long Range RFID techniques and initial hardware designees.					
FY 2017 Plans: Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2016 less those noted as complete above. Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction: - Continue all efforts of FY 2016 less those noted as complete above. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2016 less those noted as complete above. Small UAV Collision Avoidance/Autonomy Technology:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2016 less those noted as complete above. Long Range Radio Frequency (RF) Identification (ID): - Continue all efforts of FY 2016 less those noted as complete above. ***FY 2018 Base Plans:*** Continue applied research in sensors, networking and communication connectivity for the purpose of developing an affordable and fully automated network of time-coordinated mono-static, bi-static and passive surveillance sensors providing real-time tracking, identification, and engagement information with persistent wide area awareness. Specifics Surveillance Technology research objectives include: Radar - research into antenna apertures, electronics, and signal processing continue to provide enhanced capability to detect, track, and automatically identify targets and threats; Signal Intelligence - the use of interferometric and sophisticated signal processing algorithms enable the detection, geolocation, tracking, and identification of targets; Network Sensing - research areas include sensor data fusion, multi-hypothesis decision making, multi-target tracking, and methods for handling and fusing disparate and intermittent data sources; and Electronic Protection - develop methods to mitigate Electronic Attack (EA) and Electromagnetic Interference (EMI) to RF sensors and networks. Electromagnetic Warfare - Efforts in this area are expanding the surveillance of adversary platforms by developing advanced signal processing techniques to bistatically detect surface vessels by sensing reflected satellite transmissions and for the detection and discrimination of small UAS in a clutter filled environment. ***FY 2018 OCO Plans:*** N/A					
Title: VACUUM ELECTRONICS POWER AMPLIFIERS	3.464	2.747	2.354	0.000	2.354

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: The overarching objective of this activity is to develop millimeter wave (MMW) and sub-MMW power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. The technology developed cannot, for the most part, be obtained through commercial off the shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. Responding to strong interests from the various user communities, efforts are focused on the development of technologies for high-data-rate communications, electronic warfare and high-power radar applications at MMW and upper-MMW regime. The emphasis is placed on achieving high power at high frequency in a compact form factor. Technologies include utilization of spatially distributed electron beams in amplifiers, such as sheet electron beams and multiple-beams, and creation of simulation based design methodologies based on physics-based and geometry driven design codes. The current specific objectives are: a) High Power Millimeter and Upper Millimeter Wave Amplifiers: Develop science and technology for high power millimeter and upper millimeter wave amplifiers including high current density diamond cathodes, sheet and multiple electron beam formation and mode suppression techniques in overmoded structures. b) Lithographic Fabrication Techniques: Develop lithographic fabrication techniques for upper-millimeter wave amplifiers. c) Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: Develop accurate and computationally effective device-specific multi-dimensional models for electron beam generation, large-signal and stability analysis to simulate device performance and improve the device characteristics. Funding decrease from FY16 to FY17 is a result of the completion of amplifier activities. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** High Power Millimeter and upper Millimeter Wave Amplifiers					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued effort to develop and experimentally demonstrate a new class of miniature, broad-band-width millimeter wave (MMW) amplifiers having five times the power-to-weight ratio of existing state-of-the-art broadband MMW amplifiers. Lithographic Fabrication Techniques: - Continued effort to develop 220 GHz millimeter-wave amplifiers employing electromagnetic structures that are microfabricated using lithographic techniques. - Continued effort to develop new 3-D microfabrication techniques for upper millimeter-wave to terahertz electromagnetic (EM) circuits in complex geometries not possible by conventional methods, enabling unprecedented design freedom for high power active and passive devices. - Completed effort to produce a high-power (>100 W) millimeter-wave vacuum electronic amplifier at G-band using microfabrication techniques developed at NRL in conjunction with a new type of high-gain interaction circuit. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Completed effort to develop a cascaded multiple-beam traveling wave amplifier, which is expected to provide unprecedented linear output power at millimeter wave frequencies (~30-40 GHz).					
FY 2017 Plans: High Power Millimeter and upper Millimeter Wave Amplifiers - Continue all efforts of FY 2016, unless noted as completed above. Lithographic Fabrication Techniques - Continue all efforts of FY 2016, unless noted as completed above.					
FY 2018 Base Plans: Conduct ongoing Vacuum Electronic applied research for: High Power Millimeter and upper Millimeter Wave Amplifiers - Complete effort to develop and experimentally demonstrate a new class of miniature, broad-band-width millimeter wave (MMW) amplifiers having five times the power-to-weight ratio of existing state-of-the-art broadband MMW amplifiers.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Lithographic Fabrication Techniques - Complete effort to develop new 3-D microfabrication techniques for upper millimeter-wave to terahertz electromagnetic (EM) circuits in complex geometries not possible by conventional methods, enabling unprecedented design freedom for high power active and passive devices Electronics - Exploratore and develop electron beam physics, beam-wave interaction structures, microfabrication techniques, RF materials, and physics-based modeling to produce designs and prototypes of compact, efficient, broadband, linear, high power devices operating at mmW & sub-mmW frequencies ***FY 2018 OCO Plans:*** N/A					
Title: NEMESIS ***Description:*** The objective is to develop a System of Systems (SoS) able to coordinate distribute EW resources against many adversary surveillance and targeting sensors simultaneously. It will benefit the warfighter by providing platform protection across the battlespace against many sensors, creating seamless cross-domain countermeasure coordination, and enabling rapid advanced technology/capability insertion to counter emerging threats. a) Develop reconfigurable and modular EW payloads, Distributed Decoy and Jammer Swarms (DDJS), effective multi-spectral countermeasures (CM), and Multiple Input/Multiple Output Sensor/CM (MIMO S/CM) for platform protection across operational domains. The increase from FY16 to FY17 in the Nemesis program is due to hardware procurement and conducting field experiments of Nemesis technologies. The decrease from FY17 to FY18 is due to: - Starting in FY 2018, all Innovative Naval Prototype (INP) and Leap Ahead Technology (LA-Tech) investments in Electromagnetic Maneuver Warfare will be shown in the new INP PE 0602792N Inotative Naval Prototypes to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** - Continued development of the NEMESIS Electronic Warfare (EW) payloads and their integration into platforms.	9.000	10.725	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued research supporting distributed control, coordination and networking of NEMESIS payloads and platforms. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	116.362	118.941	79.598	0.000	79.598

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE supports the development of technologies that address technology needs associated with Naval platforms for new capabilities in EO/IR Sensors, Surveillance, Electronic Warfare, Navigation, Solid State Electronics, Vacuum Electronics Power Amplifiers, and Nanoelectronics. The program supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection, Time Critical Strike, and Information Distribution. Each PE Activity has unique goals and metrics, some of which include classified quantitative measurements. Overall metric goals are focused on achieving sufficient improvement in component or system capability such that the 6.2 applied research projects meet the need of, or produce a demand for, inclusion in advanced technology that may lead to incorporation into acquisition programs or industry products available to acquisition programs.

Specific examples of metrics under this PE include:

- Provide a secure, over the horizon, on-the- move capability to communicate with higher headquarters at a data rate of 256-512 Kbps at a cost of $75,000.
- Provide an array configuration suitable for installation on aircraft that will support Tactical Common Data Link (TCDL) data rates of 10.7 and 45 Mbps at greater than 150 nautical mile range.
- Develop prototype Ku band phased array apertures in a form factor suitable for installation on the CVN-78.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602435N *I Ocean Wrfghtg Env Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	69.703	42.618	42.411	-	42.411	45.132	44.838	45.000	45.900	Continuing	Continuing
0000: *Ocean Wrfghtg Env Applied Res*	0.000	40.738	42.618	42.411	-	42.411	45.132	44.838	45.000	45.900	Continuing	Continuing
9999: *Congressional Adds*	0.000	28.965	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.965

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE provides the unique, fundamental programmatic instrument by which basic research on the natural environment is transformed into technological developments that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). The objectives of this program are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting naval material and operations in the BSE. This program provides for BSE technological developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff, with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare.

This PE fully supports the Director of Defense Research and Engineering's Science and Technology Strategy and is coordinated with other DoD Components through the Defense Science and Technology Reliance process. Work in this program is related to and fully coordinated with efforts in accordance with the on-going Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the BSE categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments. Within the Naval Transformation Roadmap, the investment will contribute toward achieving each of the "key transformational capabilities" required by Sea Strike, Sea Shield, and Sea Basing. Moreover, environmental information, environmental models, and environmental tactical decision aids that emerge from this investment will form one of the essential components of FORCEnet (which is the architecture for a highly adaptive, human-centric, comprehensive maritime system that operates from seabed to space). The Navy program includes efforts that focus on, or have attributes that enhance, the affordability of warfighting systems.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602435N *I Ocean Wrfghtg Env Applied Res*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	72.252	42.618	43.368	-	43.368
Current President's Budget	69.703	42.618	42.411	-	42.411
Total Adjustments	-2.549	0.000	-0.957	-	-0.957
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.964	0.000			
• SBIR/STTR Transfer	-1.585	0.000			
• Program Adjustments	0.000	0.000	-0.957	-	-0.957
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *AGOR Mid-life Refit*	28.965	0.000
Congressional Add Subtotals for Project: 9999	28.965	0.000
Congressional Add Totals for all Projects	28.965	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602435N / *Ocean Wrfghtg Env Applied Res*	Project (Number/Name) 0000 / *Ocean Wrfghtg Env Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Ocean Wrfghtg Env Applied Res*	0.000	40.738	42.618	42.411	-	42.411	45.132	44.838	45.000	45.900	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides technologies that form the natural environment technical base on which all systems development and advanced technology depend. Furthermore, this technical base provides developments that may be utilized in the Future Naval Capabilities programs: Organic Mine Countermeasures (MCM) and Autonomous Operations. This project contains the National Oceanographic Partnership Program (NOPP) (Title II, subtitle E, of Public Law 104-201) and efforts aimed at understanding and predicting the impacts of underwater sound on marine mammals.

Major efforts of this project are devoted to: gaining real-time knowledge of the Battlespace Environment (BSE), determining the natural environment needs of regional warfare, providing the on-scene commander with the capability to exploit the environment to tactical advantage and, developing atmospheric research related to detection of sea-skimming missiles and strike warfare. This project provides natural environment applied research for all fleet operations and for current or emerging systems, and continuing support to research vessels of the U.S. Academic Research Fleet for operations, maintenance, repair and upgrades that enable applied research at sea and provides modeling and analysis for environmental compliance for ONR/NRL field work and active acoustic experiments. Major developments are routinely transitioned to the Fleet Numerical Meteorology and Oceanography Center and to the Naval Oceanographic Office where they are used to provide timely information about the natural environment for all fleet operations.

Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Efforts include ocean and atmospheric analysis and prediction for real-time description of the operational environment, shallow water acoustics, multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on MCM and Anti-Submarine Warfare (ASW) systems. Joint Strike Warfare efforts address issues in air battlespace dominance. Efforts include influences of the natural environment on air operations, electromagnetic (EM)/electro-optic (EO) systems used in intelligence, surveillance, reconnaissance, targeting, bomb damage assessment, and detection of missile weapon systems. They also include improvements in tactical information management about the BSE.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Coastal Geosciences/Optics	6.071	6.604	7.904	0.000	7.904
Description: The goal of this activity is to determine the sources, distribution, and natural variability (concentration and properties) of optically important matters in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare. The funding increase from FY 2017 to FY 2018 supports expansion of the development of new Coastal Geosciences/Optics sensors on operational platforms.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total

FY 2016 Accomplishments:
- Completed development of the BMFC (Benthic Microbial Fuel Cell) into a functionally capable technology practical for powering Navy devices.
- Completed the effort to combine optical (Vis/SWIR/TIR) and passive microwave (PM) data to (1) improve the performance of the existing NRL microwave soil moisture (SM) and vegetation water content (VWC) algorithm near inland waterways and heavily vegetated regions at 40-km resolution; and (2) develop a down-scaling algorithm to generate SM and VWC data globally at 1 km spatial resolution, which is critical but unfilled DoD requirement for determining soil strength at spatial scales required for Marine Crops/Army mobility predictions.
- Continue the effort to develop new methods using sparse representation theory for global inversion of marine gravity to deep-water seafloor topography.
- Initiated studies to reduce uncertainties in data-assimilative littoral models in data-sparse environments
- Initiated analysis of historic remote sensing modalities to determine whether robust climatologies can be developed which provide utility for initialization of littoral geosciences forecast models in data-poor regions.
- Initiated a baseline study of littoral geosciences environmental variables and their value, singly or in combination, to reducing uncertainty of inverse and forward models, in data-poor regions

FY 2017 Plans:
- Continue all efforts of FY 2016 less those noted as completed above.
- Complete the effort to develop new methods using sparse representation theory for global inversion of marine gravity to deep-water seafloor topography.
- Initiate development of new technologies and methodologies to delineate suspended sediment orientations in the water column and the turbulent motions which give rise to their spatial distributions, in response to the highly varied forcing of the littoral region.

FY 2018 Base Plans:
Conduct research investments in this activity support the development and testing of expendable and autonomous bioluminescence sensors, the continued development of extended range underwater imaging technologies, and algorithm development and testing for application to ocean color remote sensing from aircraft and space in order to characterize key features of the coastal battle space such as bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties. Complete the effort to demonstrate an extremely compact hyperspectral imager (HSI) employed to retrieve coastal environmental products, ultimately from very small UAVs, by modifying a prototype sensor, incorporating smartphone technology for control and processing and evaluate the performance for quantitative retrieval of environmental products. Complete the

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
effort to couple sediment models that use accurate numerical representations of coastal sediment dynamics with coastal optical modeling systems in order to accurately forecast the appearance and persistence of near-bottom turbidity layers and sediment re-suspension events. Undersea Warfare Applied research focused on minimizing the logistics burden of persistently maintaining multiple sensors in remote or challenged locations. The research emphasizes technologies leading to non-platform-based systems through novel power sources and power-harvesting. For example, benthic microbial fuel cells (BMFCs) are prototype power supplies that generate power from the oxidation of sedimentary organic matter and are intended for marine deployed sensor systems presently powered by batteries. BMFCs can provide power for long-term, uninterrupted operation of Anti-Submarine Warfare; Intelligence, Surveillance and Reconnaissance; and scientific systems otherwise limited in operational lifetime by battery depletion. Battlespace Environments Conceptualize and perform laboratory, field, and numerical modeling studies to understand and exploit various geoscience and optical environmental phenomena in areas that are scientifically challenging, require innovation, and are of interest to the Navy/Marine Corps. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments designed to understand geological/geophysical, biological, and optical phenomena in the oceans and littoral zones, and to validate that understanding. Includes efforts to develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and though-the-sensor techniques to obtain, store, utilize, merge and/or exploit data and create operationally and tactically useful environmental information of the littorals and bottom. This includes specification and development of sensors, signal processing, inversion, and other analysis tools when needed. ***FY 2018 OCO Plans:*** N/A					
Title: Marine Mammals and Biology ***Description:*** The Marine Mammals and Biology program focus is to better understand and characterize the effects of underwater sounds produced by Navy sources (especially sonar) on marine mammals. Efforts include research on integrated ecosystems, effects of sound exposure on marine mammals, and improving the monitoring and detection of marine mammals. The research in this program supports Navy environmental	3.448	3.446	3.407	0.000	3.407

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total

compliance information needs and facilitates acquiring LOAs from NOAA that enable all Navy training and testing operations, and the development of appropriate state-of-the-art mitigation measure.

FY 2016 Accomplishments:
- Continued at-sea demonstration of radar and acoustics systems to monitor marine mammals in fleet activities.
- Continued multi-investigator, coordinated field research to test responses of marine mammals (especially beaked whales) to controlled sound exposures.
- Continued development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery.
- Continued research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts).
- Continued research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters.
- Continued development of and evaluated models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise.
- Continued development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish.
- Continued research on the physiology and stress of marine mammals in the wild.

FY 2017 Plans:
- Continue all efforts of FY 2016 less those noted as completed above.

FY 2018 Base Plans:
Integrated Ecosystem Research: Conduct research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Initiate a multidisciplinary approach using tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields.

Effects of Sound: Conduct research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. Initiate research to characterize the causal chain of events leading from sound exposure to "biologically significant" behavioral reactions that might increase risks of population-level effects and/or the potential for stranding. Conduct research to develop an understanding of the natural variation of stress markers, better understand and characterize the relationships among hormones

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
or other biomarkers in different matrices and characterize the relationship between the physiological stress response in marine mammals and acoustic exposure. Monitoring and Detection: Conduct research to develop and test new and existing technology to detect and classify marine mammals in the marine environment and during periods of low light. Continue the development and testing of new autonomous hardware platforms using passive acoustics and/or IR to detect and classify marine mammals. ***FY 2018 OCO Plans:*** N/A					
Title: Marine Meteorology ***Description:*** The marine atmosphere affects most aspects of naval operations. This activity develops observing technologies, models, Numerical Weather Prediction (NWP) systems and Tactical Decision Aids (TDA) that describe the atmospheric environment and its impacts on naval sensors and operations. This activity focuses on uniquely marine aspects of atmospheric science such as air-sea interaction, coupled ocean-atmosphere modeling, EM and EO propagation, coastal meteorology, Tropical Cyclone (TC) prediction, and the use of remote sensing to obtain quantitative observations of atmospheric properties. Aspects of the atmospheric environment of particular interest include near-surface phenomena that affect refractivity, marine boundary layer dynamics that affect clouds, rain, visibility and fog, and processes that control TC structure, track, and intensity. Objectives of this activity are improved NWP systems and TDAs that provide NOWCAST and forecast skill at global, regional, and tactical scales for operational support, sensor and system development, and performance prediction. The funding decrease from FY 2017 to FY 2018 reflects the completion of efforts to produce the first numerical weather prediction model of operational accuracy covering the entire middle atmosphere. ***FY 2016 Accomplishments:*** - Continue the effort to produce the world's first numerical weather prediction model of operational accuracy covering the entire middle atmosphere. - Complete the design, assembly, testing and delivery of a threat detection technology for Tier 1 environmental analysis of aerosols.	10.681	10.807	9.419	0.000	9.419

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete the development of the ability to accurately detect, monitor and forecast the 3-D areal extent of global airborne dust, volcanic ash, and smoke and improve aerosol optical depth analyses and forecasts through the use of a suite of satellite sensors and the Navy Atmospheric Aerosol Prediction System (NAAPS). - Complete the development of a Hybrid Ensemble 4D-VAR Data Assimilation (DA) scheme for regional models based on the global data assimilation techniques, in order to simultaneously estimate regional and global model initial conditions. - Completed development of a quantitative prediction capability of EM propagation (EMProp) and sensor performance through improved mesoscale modeling, and characterize the uncertainty in these predictions due to the environment and propagation models. - Completed the effort to develop and evaluate a global coupled atmosphere-ocean system that can accurately simulate and predict the Madden Julian Oscillation (MJO), which is a phenomenon that serves as a bridge between current weekly forecasts and extended-range forecasts.					
FY 2017 Plans: - Continue all efforts of FY 2016 less those noted as completed above. -Complete the effort to produce the world's first numerical weather prediction model of operational accuracy covering the entire middle atmosphere. - Initiate development of a high-altitude version of the tropical cyclone intensity prediction model (COAMPS-TC) to incorporate new upper-level physics that affect storm dynamics. - Initiate development of a probabilistic tropical cyclone forecasting system, based on the COAMPS-TC ensemble, that generates probabilistic guidance and quantifies the forecast uncertainty. - Initiate development of a high resolution global weather prediction system (based on NAVGEM) with an improved dynamical core, increased resolution (approx. 10km and 100 layers), physics upgrades, new physics-dynamics coupling, and advances in the NAVDAS-AR data assimilation system.					
FY 2018 Base Plans: Continue all efforts of FY 2017 less those noted as completed above. Perform field measurements; theoretical analyses; development of data fusion, data assimilation and modeling technologies; increasing knowledge content of data from remote sensing and through-the-sensor systems; exploring dynamical and physical processes, coupled atmosphere/ocean/wave/ice/land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments and telescoping, global-to-tactical scale numerical simulations specifically designed to understand atmospheric environmental					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
processes and phenomena. Includes efforts to develop appropriate inversion and other techniques to obtain atmospheric environmental data from airborne and spaceborne sensors. Includes empirical and numerical model development techniques and associated efforts designed to improve atmospheric prediction, diagnose problems and increase the efficiency and accuracy of those models and model systems in a variety of computational environments. Includes efforts to fuse, merge and exploit atmospheric data and create operationally useful information. The research is coordinated with operational customers to enable rapid transition of research into operations. Initiate the development of a version of the Navy's regional NWP prediction system (COAMPS) that incorporates new physics and is optimized to provide much more accurate forecasts in the Arctic, particularly for poorly predicted phenomena like polar lows, and couples with ocean and ice forecast models. Complete the effort to utilize satellite microwave radiometers to introduce a reliable sea spray source term and demonstrate the new source term within the Navy Aerosol Analysis and Prediction System (NAAPS) for the purposes of global aerosol modeling to produce reliable forecasts of EO propagation, weather, and climate, as a result of the ability to accurately model maritime aerosols. Complete the effort to develop a unique, flexible, situation-dependent, operational METOC nowcast support capability to improve nowcast skill based on dynamic ship-following, high-resolution, rapidly updated data assimilation and mesoscale modeling called CSI (COAMPS-OS Ship-following Infosphere). ***FY 2018 OCO Plans:*** N/A					
Title: National Oceanographic Partnership Program (NOPP) ***Description:*** This activity focuses on US Navy investments in the National Oceanographic Partnership Program (NOPP). NOPP, established by the US Congress (Public Law 104-201) in Fiscal Year 1997, is a unique collaboration among 15 federal agencies involved in conducting, funding, or utilizing results of ocean research. NOPP's value to the Navy derives from the capacity of the partnership to enable and ensure multi-agency efforts where such collaboration enhances efficiency or effectiveness, and/or reduces costs. Generally, NOPP investments are made on topics that cross-agency missions, fall in gaps between agencies and/or are too large for any one agency to fund itself. ***FY 2016 Accomplishments:*** - Initiated marine mammal tagging as a component of the marine arctic ecosystem dynamics study.	7.964	8.626	8.611	0.000	8.611

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated development of coupled Arctic System Models to support improved forecasting and prediction of sea ice and other operational parameters - Initiated efforts to seamlessly nest high-resolution regional ocean models into tide-resolving global HYCOM ocean forecasts - Initiated project to understand the role of the ocean in providing skill in extended-range predictions of the environment through systematic model intercomparisons ***FY 2017 Plans:*** - Continue all efforts of FY 2016 less those noted as completed above. ***FY 2018 Base Plans:*** Development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to affect it, modernization of ocean research and observation infrastructure, and marine mammal-related research. Specific research activities include conducting studies to develop an integrated coastal ocean observation system and associated sensors, communications, data acquisition, storage and processing tools. Efforts will also be initiated to develop small space-based sensors for littoral oceanographic and atmospheric dynamics research; tools for improved production and application of high resolution sea surface temperature data; and miniaturized, next generation sensors for ocean measurements. ***FY 2018 OCO Plans:*** N/A					
Title: Ocean Acoustics ***Description:*** This activity is dedicated to the determination of the impact of the natural ocean environment on acoustic wave phenomena in support of naval undersea warfare and underwater force protection operations. This activity studies underwater acoustic propagation, scattering from ocean boundaries, and ambient noise issues that impact the development and employment of acoustic systems. The Littoral Zone (LZ) has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic systems, are the shallow water included in the Littoral Zone, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to rapid changes of the ocean structure. The objectives of this program are met through measuring, analyzing, modeling and simulating, and exploiting ocean acoustic factors to gain advantage over potential adversaries using undersea acoustic systems. Results of this activity support acoustic sensor and system development, performance prediction, and tactical decision aids.	2.493	2.288	2.060	0.000	2.060

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FY 2016 Accomplishments: - Continue effort to reduce acoustic propagation forecast error through a coupled ocean-acoustic assimilative model. - Continued development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. - Continued development of a Tactical Decision Aid (TDA) that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. - Continued development of a validated, physics-based processing algorithm that diagnoses acoustic performance directly from oceanographic data. - Continued development of a set of physics-based environmental acoustic metrics to evaluate the predictions of TDAs that are used in planning asset allocation and placement of distributed Autonomous Undersea Vehicles (AUVs) in a time evolving scenario. - Continued development of improved performance predictions for sonar surveillance systems that utilize horizontal line arrays operating in shelf-break environments and relate horizontal-array signal gain and coherence length to the statistics and scale lengths of transverse environmental inhomogeneities. - Continued development of an ocean magnetic prediction system for magnetic fields generated by high amplitude internal waves, internal bores, and internal solitary waves. - Complete enhancements to the accuracy of acoustic performance predictions through stochastic algorithms dealing with environmental uncertainty. - Completed development of a coupled algorithm to assimilate in-situ acoustic data into an acoustic model used for autonomous system decision support. - Completed effort to develop a new through-the-sensor environmental characterization capability for multistatic sonobuoy systems.					
FY 2017 Plans: - Continue all efforts of FY 2016 less those noted as completed above. - Complete effort to reduce acoustic propagation forecast error through a coupled ocean-acoustic assimilative model.					
FY 2018 Base Plans: Undersea Warfare applied research to provide the Warfighter with improved Anti-Submarine Warfare (ASW) performance assessment models and tactical decision aids to plan ASW operations, evaluate effectiveness of ASW systems, and enable environmental adaptive system control. The capability to provide ASW sensor					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
and system performance models, realistic simulations, and measures of effectiveness that incorporate and exploit critical environmental knowledge requires coupling ocean dynamics and acoustics, ambient noise characterization in the littorals, acoustic and optical scattering and propagation characterization, through-the-sensor measurement techniques for in situ environmental parameters, measurement and prediction of uncertainty, and development of tactical decision tools. Efforts include continuation of applied research to enhance passive sonar performance capability in the Arctic environment by developing a better passive sonar performance prediction model and new acoustic ice-characterization methods. ***FY 2018 OCO Plans:*** N/A					
Title: Physical Oceanography ***Description:*** The goal of this activity is to develop naval tactical uses of knowledge of the physics of the ocean within the BSE. This is achieved through the development of predictive models of the water mass structure, waves, currents, and air-sea interactions and developing measurement/observation technology. Other applications utilize knowledge of the interaction of the water column hydrodynamics and the acoustics to predict the undersea transmission characteristics and sources of uncertainty in these statistics. Utilizing knowledge of the ocean surface physics, the physical oceanography program seeks to exploit the combination of remotely sensed data, in-situ data, and adaptively sampled data to optimize predictions of ocean currents and water column structure. These predictions, custom databases, adaptive sampling schemes and data programs serve Anti-Submarine Warfare (ASW), Naval Special Warfare (NSW), Sea-Basing, and mine warfare needs. ***FY 2016 Accomplishments:*** - Completed the development of the calibration of ocean forcing and its uncertainty using satellite flux estimates and ocean observations propagated through the ocean physics to the surface. - Initiated multi-scalable visuzalization tools using GPU's, tablets and remote sensing data. - Initiated testing of Air-Deployed Ocean Profiler in research and fleet test. - Initiated development of a coupled atmosphere-ocean-cryosphere-wave prediction system capable of forecasts from the submesoscale to decadal. - Initiated development of a high resolution Arctic ice/ocean/weather/wave prediction system that can assimilate SAR data. - Initiated Synthetic Aperture Radar Data Assimilation for Tropical Storm Forecasts	10.081	10.847	11.010	0.000	11.010

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated Expendable Expeditionary Data Fusion Development					
FY 2017 Plans: - Continue all efforts of FY 2016 less those noted as completed above. - Complete the effort to develop the Navy's coupled ocean-atmosphere variational data assimilation (DA) system. - Initiate the development and testing of the Remote Ocean Sampling System for air-sea surface flux sampling - Initiate the development of advanced autonomy for operations of gliders and uuv's in extreme environments - Initiate the development of ocean drifters with stable salinity sensors and high resolution turbulence sensors					
FY 2018 Base Plans: Conduct applied research including field research on ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore and riverine environments is directed towards model system development and analysis. Model and data assimilation development is extending to the field of coupled models including air-ice-wave-ocean-land models. This encompasses the design, analysis and underlying theory of field and laboratory experiments designed to understand ocean environmental processes and phenomena. It includes model development to improve ocean environmental predictive capabilities, through improved physical characterization, diagnosis, efficiency and accuracy of these models in a variety of computational environments. Also includes efforts to develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and "through the sensor" techniques to obtain physical oceanographic environmental data. Includes effort to fuse and exploit oceanographic data to create operationally useful information. Conduct applied research that develops and tests the Remote Ocean Sampling System for the air-sea surface flux sampling, while also developing an advanced autonomy for operations of gliders plus UUV's in extreme environments and develop ocean drifters with stable salinity sensors and high resolution turbulence sensors. Completion of the effort to develop a capability to estimate global ocean forecast uncertainty from ensembles which will enable risk assessment with skill out to 30 days, providing the real-time assessment of environmental uncertainty anywhere on demand and risk analysis products that can be used as inputs to existing decision support tools such as risk quantification and mission planning. Completion of the effort to develop a new capability for accurate and rapid characterization of the local ocean battlespace utilizing the ability of gliders to work in coordinated teams and 4-dimensional variational assimilation (4D-Var) to maximize impact of the glider data in a high resolution local forecast model for more accurate ocean predictions around Sea Base and Sea Strike areas.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The research is coordinated with operational customers to enable its rapid transition into operational systems. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	40.738	42.618	42.411	0.000	42.411

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

All Science and Technology model improvements undergo a rigorous validation verification and evaluation against quantifiable metrics before being accepted for transition into operations. In Marine Meteorology, for example, typical improvements over the past decade have amounted to a gain in skill of one forecast-day (i.e., the 4-day forecast is now as skillful as the 3-day forecast of a decade ago), and tropical cyclone forecast track error has been reduced by 50%. It is expected that future increases in skill will continue at or above this pace.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602435N / *Ocean Wrfghtg Env Applied Res*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	28.965	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.965

A. Mission Description and Budget Item Justification

The AGOR Mid-Life Refit FY15 funding will support the overhaul, re-fit and upgrade of Navy research vessel THOMAS G THOMPSON (AGOR 23). In FY15 funds will be awarded to the University of Washington, the operator of THOMPSON, to support the competitive selection of a US shipyard which will implement the design plans. The THOMPSON entered the Vigor, Seattle shipyard in June 2016 to begin the 11-month refit.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: AGOR Mid-life Refit	28.965	0.000
FY 2016 Accomplishments: The AGOR Mid-Life Refit FY16 funding represents an increase of $10M more than FY15, and provides full funding in this FY for the second vessel, AGOR 24 Roger Revelle. A contract with the University of California-San Diego's Scripps Institution of Oceanography will be developed to manage the project during FY16, with a major shipyard overhaul preliminarily planned for FY18. Deliverables will support environmental compliance requirements regarding ballast water treatment, marine sanitation, engine exhaust, incinerator exhaust, air conditioning refrigerants, and oily-water separation. Additional deliverables will overcome obsolescence of diesel engine and electrical system components, and enhanced the ship safety with piping replacements in the ship's firemain and ballast water systems.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	28.965	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Deliverables will support new environmental compliance requirements regarding ballast water treatment, marine sanitation, engine exhaust, incinerator exhaust, air conditioning refrigerants, and oily-water separation. Additional deliverables will overcome obsolescence of diesel engine and electrical system components, and enhance the ship safety with piping replacements in the ship's firemain and ballast water systems.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602651M *I JT Non-Lethal Wpns Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	5.956	6.327	6.425	-	6.425	6.425	6.425	6.425	6.553	Continuing	Continuing
0000: *JT Non-Lethal Wpns Applied Res*	0.000	5.956	6.327	6.425	-	6.425	6.425	6.425	6.425	6.553	Continuing	Continuing

A. Mission Description and Budget Item Justification

The DOD Non-Lethal Weapons (NLW) Program was established by the Office of the Secretary of Defense, which designated the Commandant of the Marine Corps (CMC) as the DoD NLW Executive Agent (EA). The EA exercises centralized responsibility for joint research and development of non-lethal weapons and technology through the Joint Non-Lethal Weapons Program (JNLWP). The Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) provides direct oversight of the JNLWP.

The efforts described in this Program Element (PE) reflect science and technology (S&T) investment decisions provided by the Joint Non-Lethal Weapons (NLW) Integrated Product Team, a multi-service flag level corporate board that provides executive oversight and management for the JNLWP for the CMC. This direction is based on the needs and capabilities of the Services, the Special Operations Command, and the Coast Guard, as identified in the DoD's Non-Lethal Weapons Joint Capabilities Based Assessment Document. This coordinated joint S&T development approach addresses mutual capability gaps and assures the best non-lethal technologies, capabilities and equipment are provided to the operating forces while eliminating duplicative service S&T investment. These applied research initiatives feed non-lethal capabilities which directly support the three pillars of the 2014 Quadrennial Defense Review and comprise a fundamental part of DoD's security cooperation efforts to build partner capacity. The resulting capabilities will facilitate a fully integrated non-lethal competency as a complement to lethal firepower, providing force application options for short-of-lethal scenarios.

This program funds the applied research, study, assessment, and demonstration of technologies that could provide a non-lethal capability or target effect. Investment areas include applied research related to: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-materiel missions; non-lethal acoustic and optical technologies; advanced non-lethal materials (including materials for vehicle/vessel stopping and counter-facility applications); associated human effects and effectiveness for new non-lethal stimuli; injury potential and effectiveness of directed energy, electric stun, ocular, and acoustic based non-lethal technologies; and developing models of crowd behavior and dynamics.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602651M *I JT Non-Lethal Wpns Applied Res*			
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	6.114	6.327	6.425	-	6.425
Current President's Budget	5.956	6.327	6.425	-	6.425
Total Adjustments	-0.158	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.158	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602651M / *JT Non-Lethal Wpns Applied Res*	Project (Number/Name) 0000 / *JT Non-Lethal Wpns Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *JT Non-Lethal Wpns Applied Res*	0.000	5.956	6.327	6.425	-	6.425	6.425	6.425	6.425	6.553	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds the applied research, study, assessment, and demonstration of technologies that could provide a non-lethal capability or target effect. Investment areas include applied research related to: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-materiel missions; non-lethal acoustic and optical technologies; advanced non-lethal materials (including materials for vehicle/vessel stopping and counter-facility applications); associated human effects and effectiveness for new non-lethal stimuli; injury potential and effectiveness of directed energy, electric stun, ocular, and acoustic based non-lethal technologies; and developing models of crowd behavior and dynamics.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: (U) JOINT NON-LETHAL WEAPONS	5.956	6.327	6.425	0.000	6.425
FY 2016 Accomplishments: - Continued academic research into technology areas with relevance to non-lethal weapon capabilities. - Continued investigations of alternative technologies with potential to address emerging capability gaps. - Continued to evaluate methodologies for measuring directed energy effects (millimeter - wave, high powered microwave, etc.) - Continued investigations of advanced materials and emergent technologies suitable for extended range non-lethal weapon payload applications. - Continued transition of foundational effects associated with advanced electro-muscular disruption technologies to higher levels of technology development and demonstration. - Continued feasibility assessment and evaluation of candidate technologies with potential to mitigate technology challenges impeding Non-Lethal Effects (NLE) capability gap resolution. - Continued applied research into characterization of non-lethal phenomena and assessment of human effects and weapon effectiveness, including development of dose response and injury correlates. - Continued investigation of component High Power Microwave (HPM) technologies and transition results to higher levels of technology development and demonstration. - Completed human effects investigation of alternative physical phenomena to non-lethally suppress humans beyond small arms range. - Completed applied research to develop a framework to analyze behavioral response to non-lethal weapons. - Completed evaluation of the feasibility and practicality study of advanced vehicle stopping design concepts.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602651M / *JT Non-Lethal Wpns Applied Res*	**Project (Number/Name)** 0000 / *JT Non-Lethal Wpns Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated evaluation of the susceptibility of targets to candidate vehicle and vessel stopping designs. ***FY 2017 Plans:*** - Continue all efforts from FY 2016, except those noted as completed. ***FY 2018 Base Plans:*** - Continue all efforts from FY 2017, except those noted as completed. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	5.956	6.327	6.425	0.000	6.425

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this Program Element is the development of technologies that lead to the next-generation of Non-Lethal Weapons. The program consists of a collection of projects that range from studies and analyses to the development and evaluation of feasibility demonstration models. Individual project metrics reflect the technical goals of each specific project. Typical metrics include both the effectiveness of the technology, human effects and effectiveness, and potential for compliance with policy and legislation. Overarching considerations include the advancement of related Technology Readiness Levels and Human Effects Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602747N *I Undersea Warfare Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	151.844	126.313	56.094	-	56.094	58.008	57.298	57.439	58.588	Continuing	Continuing
0000: *Undersea Warfare Applied Res*	0.000	125.679	126.313	56.094	-	56.094	58.008	57.298	57.439	58.588	Continuing	Continuing
9999: *Congressional Adds*	0.000	26.165	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	26.165

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Sep 2011). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE funds applied research efforts in undersea target detection, classification, localization, tracking, and neutralization. Technologies being developed within this PE are aimed at enabling Sea Shield, one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new Anti-Submarine Warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets. Research focused on understanding the impacts on marine mammals of manmade underwater sound is also conducted in the Program Element , as well as continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable applied research at sea.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602747N *I Undersea Warfare Applied Res*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	150.839	126.313	100.501	-	100.501
Current President's Budget	151.844	126.313	56.094	-	56.094
Total Adjustments	1.005	0.000	-44.407	-	-44.407
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	4.970	0.000			
• SBIR/STTR Transfer	-3.965	0.000			
• Program Adjustments	0.000	0.000	-44.407	-	-44.407
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Undersea Warfare Research*	17.958	0.000
Congressional Add: *Underwater Energetics Research*	8.207	0.000
Congressional Add Subtotals for Project: 9999	26.165	0.000
Congressional Add Totals for all Projects	26.165	0.000

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the Innovative Naval Prototype (INP) Forward Deployed Energy & Communications Outpost (FEDCO), the INP Anti-Submarine Warfare Mission Package (ASW MP), and the INP Large Displacement Unmanned Underwater Vehicle (LDUUV) to the new PE 0602792N Innovative Naval Prototypes Applied Research.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602747N / *Undersea Warfare Applied Res*	Project (Number/Name) 0000 / *Undersea Warfare Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Undersea Warfare Applied Res*	0.000	125.679	126.313	56.094	-	56.094	58.008	57.298	57.439	58.588	Continuing	Continuing

A. Mission Description and Budget Item Justification

This PE funds applied research efforts in undersea target detection, classification, localization, tracking, and neutralization. Technologies being developed within this project are aimed at enabling Sea Shield which is one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new ASW operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: ANTI-SUBMARINE WARFARE (ASW) DISTRIBUTED SEARCH	20.829	29.906	15.274	0.000	15.274
Description: ASW Distributed Search focuses on the development of technologies for the non-covert tactical search for undersea targets ranging from hours to weeks, using automated sensor systems deployed around operating areas, including along key transit routes to protect naval/maritime forces, around temporarily fixed sea base regions and naval force operating areas, or around fixed defensive regions and areas of interest, such as key US/Allied ports. "Non-covert" implies availability of airborne assets for sensor deployment (although other means may also be used), and the ability to employ active sonar along with passive and non-acoustic methods. "Search" is conducted in concentrated areas, typically exploiting cues received from surveillance systems. The submarine target must be detected beyond its weapons release range. The objective is to develop rapidly deployable systems employing automated detection and classification capabilities for use in both shallow and deep water operating environments. Distributed Search supports the ASW protected passage Maritime Shield operational constructs. Related efforts include the development of distributed systems employing optimization as well as active acoustic sensing and processing techniques, navy-unique transduction and underwater networking technology. Efforts also include the development of Unmanned Undersea Vehicle-based and affordable off-board deployable sensing systems employing persistent detection concepts and components. These efforts provide an extended reach of organic platform-based systems through the use of new sensor concepts, improved materials for advanced sensors, optimized deployment, employment, and automated operation of distributed sensor fields. The cornerstone of Distributed Search is the development of rapidly deployable, long-endurance active sensors with automated processing suitable for use in a wide variety of operational environments.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Funding increase from FY 2016 to FY 2017 is due to the increase in the number of objective experiments and the demonstration at the end of FY17 for the FDECO program and the associated integration events associated with the FDECO program. Funding decreases from FY 2017 to FY 2018 due to the move of the Forward Deployed Energy & Communications Outpost (FDECO) INP Program to a new innovative naval prototype PE 0602792N Innovative Naval Prototypes Applied Research. ***FY 2016 Accomplishments:*** - Furthered development of "intelligent" algorithms aimed at improving ASW performance of distributed multistatic sonar systems. - Completed development of a thermophone acoustic projector technology for use in sonar applications. - Completed effort to develop compressive beamforming algorithms for vector sensor towed arrays. - Completed development/improvement of multi-static signal processing techniques for systems employing coherent sound sources. - Completed research into the characterization and classification of deep-ocean clutter sources to improve active sonar system performance in Convergence Zone (CZ) and other deep-ocean propagation conditions. - Initiated development of signal and information processing algorithms for improved ASW performance of high duty cycle active sonar systems. - Initiated the Forward Deployed Energy & Communications Outpost (FDECO) INP project. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. ***FY 2018 Base Plans:*** Undersea Warfare Applied research focused on technologies that enable both platform-based and off-board systems to detect and classify the ultra-quiet, low-Doppler submarine threat in complex operating environments. The capability to provide non-covert ASW tactical search for both shallow and deep water operational areas against all submarine threats requires improved sensor technology to extend the capabilities of platform-based systems; innovative sensor technology for off-board and rapidly deployable systems; characterization of and signal processing to control reverberation, clutter, and noise; characterization of target radiation and scattering physics for all					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
threat submarines; physics-based detection and classification algorithms with automation where possible; and knowledge and exploitation of the complex operational environment. Conduct Signal processing-related research which focuses on multistatic active sonar concepts that operate in convergence zone environments, high duty cycle active sonar, and developing concepts for next-generation active sonar system automation. Complete effort to develop a new generation of target detection algorithms that use advanced simulations of small targets floating on a dynamic sea surface. Complete effort to develop and demonstrate real time onboard processing for a UUV to detect, classify, and track submarines using active sonar. Complete effort to develop a new class of magnetic sensor with ultra-low power consumption to enable persistent magnetic field sensing as a surveillance technology. ***FY 2018 OCO Plans:*** N/A					
Title: ANTI-SUBMARINE WARFARE (ASW) PRECISION LOCALIZATION	3.281	3.415	3.452	0.000	3.452
Description: Precision Localization focuses on the development and demonstration of technologies which use information from surveillance or search systems to determine an area of uncertainty (AOU) relative to target range, bearing, and depth adequate to handoff to an attack system. Precision Localization employs non-acoustic techniques such as magnetic and optical sensing to highly localize submerged threats. The objective is to increase magnetic sensor range and robustness, enable deployment on Unmanned Air Vehicles (UAVs), and increase optical sensing search rates. Efforts include the development of non-traditional tracking and advanced magnetic and electric field sensors and processing. These technologies will provide a decreased AOU size thus enabling the effective use of smaller, more versatile torpedoes as well as increased performance gain in detection, targeting, tracking/trailing, and homing via target acquisition and covert prosecution. ***FY 2016 Accomplishments:*** - Continued effort to develop improved electrodes and signal processing techniques to improve detection range using undersea electric field sensors. - Continued development of non-traditional tracking methods and systems for deployment on air vehicles. - Continued development of low-cost, platform based sensor networks. - Continued development of quantum sensor technologies for Magnetic Anomaly Detector (MAD). - Continued development of a non-traditional tracking system for deployment on undersea vehicles. - Continued testing of a non-traditional tracking system.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems. - Continued an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications. - Continued an effort to extend the technology base for high performance electro-optic detectors and filters suitable for Undersea Warfare applications including underwater communications. - Continued an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems. - Continued an effort to develop optical signal processing and hybrid computing technology appropriate for Undersea Warfare and underwater communications systems. - Continued development of ASW sensor technologies capable of being deployed by a gun or missile launcher.					
FY 2017 Plans: - Continue all efforts of FY 2016, unless noted as completed above. - Complete effort to develop improved electrodes and signal processing techniques to improve detection range using undersea electric field sensors.					
FY 2018 Base Plans: Magnetic and Electric Field Sensing Conduct basic research related to critical S&T for Precision Localization using magnetic and electric field sensing technologies. Executed research into novel methods to develop smaller and power efficient, high performance magnetic and electric field sensors. Pursued research on advanced concepts for processing arrays of independent sensors to create adaptive magnetic and electric field sensor systems. Expanded research to include remote methods of sensing magnetic fields. Optical Sensing Conduct basic research related to critical S&T for Precision Localization using optical sensing technologies. Executed research to better exploit the information capacity available in photonic systems toward development of higher performance optical sensors. Pursued information theoretic optical sampling and telemetry characteristics to better support sensor performance and data integrity. Extend the effectiveness that photonic sensors to operate across the air-water interface. Extend the distance optical sensors can effectively operate within the water column.					
FY 2018 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE	85.852	77.223	21.617	0.000	21.617
Description: ASW Surveillance focuses on dramatically improving detection, classification, and localization capabilities in large ocean areas relative to the capabilities of legacy ASW surveillance systems. The related technologies support the conduct of covert, wide-area surveillance ranging from one day to six months. The objectives are to develop and demonstrate technologies that provide clandestine indications and warnings in far forward and contested operating areas, and in complex operational environments against all submarine threats, including new threats with unknown target signatures and tactics. Covertness implies use of non-observable platforms and/or deployed automated sensors employing passive sonar, or other non-detectable methods. The surveillance process includes initial detection and classification. Efforts include the development of Unmanned Undersea Vehicle-based and affordable, off-board deployable sensing systems employing a wide variety of surveillance concepts and components. These efforts focus on alternative detection phenomena, vector/tensor sensors, automated acoustic processing, more compact and longer lasting power sources, and high bandwidth, acoustic communications links. The decrease from FY 2016 to FY 2017 due to the completion of a portion of the Innovative Naval Prototype (INP) -Large Displacement Unmanned Underwater Vehicle (LDUUV) effort to development an Autonomous Underwater Vehicle (AUV)-deployable bottom surveillance array networked by low complexity acoustic modems. FY 2017 to FY 2018 funding decreases due to the INP-Large Displacement Unmanned Underwater Vehicle (LDUUV) & INP Anti Submarine Warfare Mission Packages (ASW MP) moving into a new innovative naval prototype PE 0602792N Innovative Naval Prototypes Applied Research. ***FY 2016 Accomplishments:*** - Completed development an Autonomous Underwater Vehicle (AUV) - deployable bottom surveillance array networked by low complexity acoustic modems. - Completed development of next generation (non-Penetrating) Power and communications technologies for underwater operations. - Initiated Select UUV for ASW mission and measure it's characteristics Leap Ahead (LA) MGMT-NEW START PREPARATIONS					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated LA Management - New Start Preparations - Conduct technology analysis and studies to support the development and validation of technology performance specifications to ensure new Leap Ahead investments are able to commence execution every other year in a timely manner. LA MGMT-SUPPORT/OPS ANALYSIS - Initiated LA Management - Support/OPS Analysis - Conduct warfighter sustainment applied research and analysis, including technology management of Leap Ahead investments supporting Department of the Navy RDT&E Corporate Board priorities for new disruptive technologies. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. LA MGMT-NEW START PREPARATIONS - Continue Leap Ahead (LA) Management - Preparations - Conduct technology analysis and studies to support the development and validation of technology performance specifications to ensure new Leap Ahead investments are able to commence execution every other year in a timely manner. LA MGMT-SUPPORT/OPS ANALYSIS - Continue LA Management - Support/OPS Analysis - Conduct warfighter sustainment applied research and analysis, including technology management of Leap Ahead investments supporting Department of the Navy RDT&E Corporate Board priorities for new disruptive technologies. - Complete effort to develop ultra-low power, high sensitivity, miniature, optically pumped scalar magnetometers for undersea surveillance. - Complete effort to develop improved electrodes and signal processing techniques to improve detection range using undersea electric field sensors. - Initiate new passive sonar signal processing technology designed to detect, classify and track next-generation nuclear submarines. ***FY 2018 Base Plans:*** Undersea Warfare Conduct applied research focused on technologies that enable detection and classification of ultra-quiet, low-Doppler submarines in complex operating environments. It emphasizes developments leading to non-platform-based and clandestine systems. The capability to provide ASW clandestine indications and warnings in far-forward and contested areas against all submarine threats requires new sensor concepts to provide improved performance in smaller packages; automated passive acoustic and non-acoustic detection and classification algorithms to eliminate the dependence on traditional ASW platforms; novel power sources and					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
power-harvesting; underwater communications; networking of distributed autonomous sensors; and knowledge and exploitation of the complex operational environment. Conduct Signal processing related research that focuses on combining information from multiple arrays in a distributed field that exploit new acoustic signatures, improve detection of weak acoustic sources obscured by clutter, and new sensor and signal processing concepts that exploit underwater acoustic propagation physics to improve the detection of weak acoustic sources in high clutter environments. ***FY 2018 OCO Plans:*** N/A					
Title: MARINE MAMMALS ***Description:*** The Marine Mammals and Biology program focus is to better understand and characterize the effects of underwater sounds produced by Navy sources (especially sonar) on marine mammals. Efforts include research on Integrated ecosystems, effects of sound exposure on marine mammals, and improving the monitoring and detection of marine mammals. The research in this program supports Navy environmental compliance information needs and facilitates acquiring LOAs from NOAA that enable all Navy training and testing operations, and the development of appropriate state-of-the-art mitigation measure. The marine mammals research conducted in this Program Element (PE) represents part of a total effort executed in coordination with complementary research performed in PE 0602435N Ocean Warfighting Environment Applied Research. This Activity has been created specifically to address the work associated with determining and mitigating the effects on the behavior of marine mammals of manmade sound transmitted underwater. ***FY 2016 Accomplishments:*** - Continued development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery. - Continued research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts). - Continued research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters.	2.794	2.579	2.510	0.000	2.510

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of and evaluate models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise. - Continued development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish. - Continued research on effects of chronic physiological stress related to acoustic exposure of marine mammals in the wild. - Completed development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. ***FY 2018 Base Plans:*** Integrated Ecosystem Research: Conduct research using animal tagging and passive acoustic monitoring to study behaviors and distributions of marine mammals relative to key environmental properties (biotic and abiotic). This includes providing a context for interpreting behavioral responses to external stimuli (i.e. anthropogenic sound), and providing basic knowledge needed for predictive models of species of concern. Effects of Sound: Conduct research on behavioral effects to potentially population-level consequences of sound exposure on marine life. Initiate research to characterize the gas management and kinetics (stores and use) in marine mammals. Conduct research into the mechanisms that enable marine mammals to dive to deep depths for long durations while mitigating, if not avoiding, health threats. Initiated research to advance our understanding of sound reception mechanisms in mysticetes (large whales) will require a thorough exploration of the anatomy surrounding the ear and the whole head combined with modeling sound propagation through various tissues of whale heads and/or bodies. Conduct research to develop an understanding of the natural variation of stress markers, better understand and characterize acute and chronic effects of the stress response on individuals and populations of marine mammals. Continue research on potential effects of Navy sources on marine mammal behavior, life functions (e.g. feeding, breeding, migrating), vital rates (e.g. adult survival, reproduction), and population level effects. Understanding the effects of naval activities on species or stocks of marine mammals, including effects on annual rates of recruitment and survival. Monitoring and Detection: Continue research and development of technology for detection, classification, and localization of marine mammals. Continue the development and testing of new autonomous hardware platforms					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
using technology to detect and classify marine mammals using a variety of fixed, towed, floating, and profiling platforms. Models & Databases: Conduct research to provide tools to support environmental compliance efforts and decision-making related to how marine mammals are affected by anthropogenic sounds. ***FY 2018 OCO Plans:*** N/A					
Title: UNDERSEA WEAPONRY ***Description:*** Undersea Weaponry focuses on the development of enabling technologies to counter threat submarines and surface vessels by increasing Probability of Kill and platform survivability, as well as developing technologies for unmanned undersea vehicles. Research performed within Undersea Weaponry supports several Naval S&T Focus Areas including Power Projection & Integrated Defense, Assure Access to Maritime Battlespace, Autonomy & Unmanned Systems, and Power & Energy. Weapon technology focus areas include: Explosives and Warheads, Guidance and Control (G&C), Simulation Based Design, Propulsion, Power Sources, Supercavitation, and Counter Weapons/Counter Measures. The ultimate goal of this activity is to provide revolutionary capabilities needed to fill Sea Shield and Sea Strike Warfighter Capability Gaps, to accommodate unique payload limitations through the development of modular and reduced sized undersea weapons based on common technology enablers (where possible), to provide improved platform pre-engagement positioning and fire-control solutions for effective weapon-to-target engagement, and provide countermeasures and counterweapons against current and next-generation undersea weapons. ***FY 2016 Accomplishments:*** - Continued limited collection and evaluation of small supercavitating vehicle. - Continued concept designs for advanced warheads. - Continued design/formulation and early-stage testing of propulsion system components for advanced undersea platforms. - Continued development and testing of technologies for rapid reaction defense against undersea threats. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:***	12.923	13.190	13.241	0.000	13.241

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602747N / *Undersea Warfare Applied Res*	**Project (Number/Name)** 0000 / *Undersea Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Conduct applied research related to critical S&T for supercavitation, advanced warheads, propulsion systems for undersea platforms and defense against undersea threats. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	125.679	126.313	56.094	0.000	56.094

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of applied research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, and reducing size and power requirements.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602747N / *Undersea Warfare Applied Res*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	26.165	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	26.165

A. Mission Description and Budget Item Justification

Related efforts include novel approaches to remote detection of ocean acoustic fields, enhanced understanding of ocean acoustic structure, new transduction materials, and novel anti-submarine warfare detection methods.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Undersea Warfare Research ***FY 2016 Accomplishments:*** Test instrument designed/constructed for remote detection of acoustic fields. Upper ocean acoustic structure characterized in open ocean test. High strain textured ceramics tested for sonar use. Initiated advanced undersea mission autonomy field effort. Initiated studies on metamaterials and acoustic flow noise processes. ***FY 2017 Plans:*** N/A	17.958	0.000
Congressional Add: Underwater Energetics Research ***FY 2016 Accomplishments:*** -Initiate assessment of global developments in energetic materials. ***FY 2017 Plans:*** N/A	8.207	0.000
Congressional Adds Subtotals	26.165	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of applied research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, and reducing size and power requirements.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602750N *I (U)Future Naval Capabilities Applied Research*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	172.511	165.103	156.805	-	156.805	158.197	156.435	169.481	182.961	Continuing	Continuing
0000: *(U)Future Naval Capabilities Applied Research*	0.000	172.511	165.103	156.805	-	156.805	158.197	156.435	169.481	182.961	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Future Naval Capabilities (FNC) Program. The FNC Program represents the requirements-driven, delivery-oriented portion of the Navy Science and Technology (S&T) portfolio. FNC investments respond to Naval S&T Gaps that are identified by the Navy and Marine Corps after receiving input from Naval Research Enterprise (NRE) stakeholders. The Enabling Capabilities (ECs) and associated technology product investments of the FNC Program are competitively selected by a 3-star Technology Oversight Group (TOG), chartered by the S&T Corporate Board and representing the requirements, acquisition, research and fleet/forces communities of the Navy and the Marine Corps.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	179.538	165.103	175.233	-	175.233
Current President's Budget	172.511	165.103	156.805	-	156.805
Total Adjustments	-7.027	0.000	-18.428	-	-18.428
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-3.570	0.000			
• SBIR/STTR Transfer	-3.457	0.000			
• Program Adjustments	0.000	0.000	-18.428	-	-18.428

Change Summary Explanation

The FY 2017 funding request was reduced by -$6.8 million as required for the Department of the Navy to comply with the Bipartisan Budget Act of 2015.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
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COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *(U)Future Naval Capabilities Applied Research*	0.000	172.511	165.103	156.805	-	156.805	158.197	156.435	169.481	182.961	Continuing	Continuing

A. Mission Description and Budget Item Justification

FNC investments are typically 3-5 years in duration. They provide a continuance of basic research by maturing technologies from a Technology Readiness Level (TRL) of 3 or 4 to a TRL of 6. All FNC products require BA2 and BA3 funded technology development, which is coordinated to ensure tangible technology products are delivered upon completion of each investment. Each year the TOG refreshes the FNC Program by approving new ECs and technology products as older ones get delivered. After transition to an acquisition program, FNC products are further engineered, integrated and, ultimately, delivered to the warfighter. The development and delivery of each FNC product is guided by a Technology Transition Agreement (TTA) that is signed by the requirements and acquisition sponsors, as well as the S&T developer.

This project supports the naval pillars of Capable Manpower, Enterprise and Platform Enablers, Expeditionary Maneuver Warfare, Force Health Protection, Forcenet, Power and Energy, Sea Basing, Sea Shield and Sea Strike. Each of these pillars is listed as a separate R-2 Activity, as is FNC Management. Under each R-2 Activity, the BA 6.2 accomplishments and plans for every Enabling Capability (EC) and Technology Product in the FNC Program are listed. ECs are composed of one or more interrelated technology products, so for clarity, each product is shown under its EC.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: CAPABLE MANPOWER (CMP)	8.934	9.753	9.929	0.000	9.929
Description: This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Capable Manpower (CMP) FNC pillar. The CMP Pillar develops deliverable technologies that provide new capabilities in manpower and personnel management, training and education, and human-systems integration for more intuitive systems.					
FY 2016 Accomplishments: EC: CMP-FY12-01 LIVE, VIRTUAL, & CONSTRUCTIVE TRAINING FIDELITY - Complete Cognitive Fidelity Synthetic Environment - Develop optimal characteristics for virtual simulations to elicit the appropriate perceptual-cognitive responses for Naval aviation training. - Complete Tactics & Speech Capable Semi-Automated Forces - Conduct applied research to develop learner-aware semi-autonomous forces. - Complete Virtual-Constructive Representations on Live Avionics Displays - Develop design guidelines for effective and safe representation of virtual and constructive assets on live displays.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602750N / *(U)Future Naval Capabilities Applied Research*	**Project (Number/Name)** 0000 / *(U)Future Naval Capabilities Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Continue Manpower Planning and Optimization Toolset - Optimize manpower variables (task allocation, job and occupation codes, billets, and training) to better estimate the manpower components of ship total ownership cost. - Continue Platform Design and Acquisition Toolset - Develop assessment reporting tools that identify the dependencies, drivers, and risks associated with different platform designs and manning configurations. EC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT) - Continue Dynamic, Adaptive & Modular Training for UAS - Expand the activity learning capability to allow automatic matching between UAS operator training objectives, specific training contexts, and computer generated force behaviors. - Continue Selection for UAS Personnel (SUPer) - Develop mission scenarios to enable testing for the knowledge, skills and abilities required to operate Navy unmanned aircraft systems and integrate them into an appropriate UAS simulator. - Continue UAS Control Station Human Machine Interface - Develop metrics that assess UAS Operator performance in terms of the likelihood of leading to successful unmanned aircraft system operation. EC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Continue Decision Making-Learning Management System (DM-LMS) - Develop new technology solutions for decision making, instructional method guidelines, and software products to plan, assess, and track decision making skill development. - Continue Digital Integrated Representation of Tactical Environment (DIRTE) - Develop new technology solutions for classroom and sustainment training and develop rapid terrain modeling and sketchpad software products to enable small unit leaders and instructors the ability to create effective decision making environments and scenarios. - Continue Simulation Tailored Training and Assessment (ST2A) - Develop new technology solutions for situated tutor techniques and unobtrusive monitoring techniques, and develop software and hardware prototypes to execute a decision making program of instruction and scenarios in simulation. EC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS TRAINING & EXPERIMENTATION (EDUCAT2E)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) - Investigate and develop an approach to an objective, metrics-driven training and experimentation capability for Fast Attack Craft and Mine Warfare threats. EC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Initiate Operational Planning Tool - Develop decision support analytic tools that enhance collaborative planning for generating and executing safe and effective navigation & operational plans. ***FY 2017 Plans:*** EC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Continue Manpower Planning and Optimization Toolset - Develop measures and metrics to assess variable work packaging, improved manpower variables (task allocation, job and occupation codes, billets, and training), and estimate manpower, personnel, and training costs to better understand ship Total Ownership Cost. - Complete Platform Design and Acquisition Toolset - Deliver new manpower and system response metrics that report on the balance between system design and manpower requirements. EC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT) - Continue UAS Control Station Human Machine Interface - Define the priority autonomy capabilities needed by operators for the Supervisory Control of next generation unmanned systems. - Complete Selection for UAS Personnel (SUPer) - Evaluate and refine tests for the selected knowledge, skills, and abilities required to operate Navy unmanned aircraft systems. - Complete Dynamic, Adaptive & Modular Training for UAS - Analyze the generalization process of pattern-of-life for computer generated forces to novel activities, locations, and scenarios. EC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Continue Digital Integrated Representation of Tactical Environment (DIRTE) - Develop a Graphical User Interface (GUI) for environment generation and the capture of relevant environmental context, including maps and terrain, to train individual Marines, small unit leaders, and company level staff. - Continue Simulation Tailored Training and Assessment (ST2A) - Develop new technology solutions for situated tutor techniques and unobtrusive monitoring techniques, and develop software and hardware prototypes to execute a decision making program of instructional scenarios in simulation.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Decision Making-Learning Management System (DM-LMS) - Define Kill Probability (KP) Measures (including non-performance) of decision making mastery for ground infantry squad leaders in order to reliably measure acquisition of expertise in psychomotor, cognitive/metacognitive, and affective domains. EC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS TRAINING & EXPERIMENTATION (EDUCAT2E) - Continue Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) - Assess Artificial Intelligence-enabled activities in the Electromagnetic Spectrum (EMS) reflecting presence of non-combatant entities in the EMS and a representation of Opposition Forces tailored to training audience proficiency and learning objectives. EC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Continue Operational Planning Tool - Develop a systematic understanding of distributed, near-real time collaboration and decision making applicable for planning and operational staff. EC: CMP-FY17-02 FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE) - Initiate Future Integrated Training Environment (FITE) - Investigate and assess technologies and methods to improve the ability to conduct Live, Virtual, and Constructive training events for the Marine Air-Ground Task Force (MAGTF). ***FY 2018 Base Plans:*** FNC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Complete Manpower Planning and Optimization Toolset - Demonstrate the new analytics to measure variable work packaging, optimize manpower variables (task allocation, job and occupation codes, billets, and training), and estimate manpower, personnel, and training costs to better characterize manpower components of overall ship total ownership cost. FNC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT) - Complete UAS Control Station Human Machine Interface - Validate the human machine interface design concepts for supervisory control and for documenting design lessons learned from user experimentation.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Complete Decision Making-Learning Management System (DM-LMS) - Research and design measures of decision making mastery for ground infantry squad leaders in order to reliably measure acquisition of expertise. - Complete Digital Integrated Representation of Tactical Environment (DIRTE) - Design the Graphical User Interface (GUI) for environment generation and the capture of relevant environmental context, including maps and terrain, to train individual Marines, small unit leaders, and company level staff. - Complete Simulation Tailored Training and Assessment (ST2A) - Assess feasibility and design solutions for situated tutor techniques and unobtrusive monitoring techniques, and develop software and hardware prototypes to execute adaptive decision making scenarios in simulation. FNC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS, TRAINING & EXPERIMENTATION (EDUCAT2E) - Complete Environment Designed to Undertake Counter A2AD Tactics, Training & Experimentation (EDUCAT2E) - Finish modeling of the pacing threat denied and degraded effects on the unit sensors of blue, joint and partner nations in a distributed, virtual/constructive training, and certification/mission rehearsal environment. FNC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Continue Operational Planning Tool - Develop new capabilities to support, plan, brief, execute, and assess the Navy planning process in order to facilitate real-time situational awareness and rapid re-planning. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-01 under a new Information Warfare R-2 Activity) FNC: CMP-FY17-01 MANPOWER, PERSONNEL & TRAINING STRATEGIC PLANNING APPLICATION - Initiate Manpower, Personnel & Training Planning Application - For this FNC, delayed one year to start in FY18, develop a fundamental understanding of the risks and uncertainties underlying Manpower, Personnel, and Training interconnections and performance drivers, including potential impact points, time delays, and pathways of decisions across the enterprise. FNC: CMP-FY17-02 FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE) - Continue Future Integrated Training Environment (FITE) - Assess feasibility and design solutions for a single world-like representation of available terrain databases, making them easily available to exercise planners, and develop initial requirements to link ground and air simulation trainers.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: CMP-FY18-01 LEARNING CONTINUUM AND PERFORMANCE AID (LCAPA) - Initiate Learning Continuum and Performance Aid (LCaPA) - Develop a fundamental understanding of the skills, training, and performance measures necessary to manage individualized learning and performance tracking. FNC: CMP-FY18-02 MANNED AND UNMANNED COMMON PLANNING PICTURE - Initiate Manned and Unmanned Common Planning Picture - Develop software heuristics and automated rule sets for future integration into a single Commander's intent planner. (In FY19, this FNC Product will be realigned within this PE to UW-FY18-01 under a new Undersea Warfare R-2 Activity) FNC: CMP-FY19-03 Fleet Training Technologies (FleeT2) - Initiate FleeT2 - Conduct analyses of representational techniques, model dynamics, and high computational tractability. (In FY19, this FNC Product will be realigned within this PE to SW-FY19-04 under a new Surface Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: ENTERPRISE AND PLATFORM ENABLERS (EPE) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Enterprise and Platform Enablers (EPE) FNC pillar. The EPE Pillar develops cross-cutting, deliverable technologies that provide new capabilities for naval service platforms that lower acquisition, operations and maintenance costs, improve system safety and availability, and improve platform survivability. The FY 2016 to FY 2017 decrease was due primarily to the completion of EPE-FY12-01 and EPE-FY13-01, and the planned ramp-down of EPE-FY14-02 and EPE-FY15-02. The FY 2017 to FY 2018 increase was due primarily to the ramp up EPE-FY15-03 New Material(s) Development & Lab Characterization, which will evaluate new material mitigation technology. ***FY 2016 Accomplishments:*** EC: EPE-FY11-01 FLIGHT DECK THERMAL MANAGEMENT	11.196	9.903	13.708	0.000	13.708

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Integrated Thermal Management System Design - Conduct small scale testing of thermal management panels. EC: EPE-FY12-01 CORROSION MITIGATION TECHNOLOGIES - Complete Corrosion Resistant Surface Treatment - Determine best Corrosion Resistant Surface Treatment among carbon, nitrogen, and carbonitration approaches. - Complete Sprayable Acoustic Damping Systems - Investigate and develop spray applied damping systems for improved structural vibration control. EC: EPE-FY12-02 INTEGRATED HYBRID STRUCTURAL MANAGEMENT SYSTEM (IHSMS) - Complete IHSMS Fleet Structural Health Management Decision Tool - Optimize physics and statistical based structural health models, rotor hot-spot sensors and integration technologies, and finalize risk reduction experiments. EC: EPE-FY13-01 TOWED ARRAY SYSTEM RELIABILITY IMPROVEMENT - Complete Tools for Predicting Array Operational Loading & Distribution - Develop a predictive model of the magnitude and distribution of hydrodynamic forces on a towed array and the effect of the forces on array internal components. EC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - Continue Aluminum Alloy Corrosion Mitigation Technologies - Investigate and develop advanced corrosion control and thermal load reduction coatings and surface treatment/repair technologies for improved corrosion and cracking resistance on aluminum substrates. - Continue Aluminum Alloy Corrosion Prediction Tool - Develop a sensitization detection tool hardware and refine the prediction algorithm for determining the rate of sensitization. EC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Develop and evaluate a set of alloys and coatings to support higher temperature capable gas turbine operation. EC: EPE-FY15-03 SPECIAL HULL TREATMENT					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue New Material(s) Development & Lab Characterization - Develop new hull treatment materials for submarines. ***FY 2017 Plans:*** EC: EPE-FY11-01 FLIGHT DECK THERMAL MANAGEMENT - Complete Integrated Thermal Management System Design - Analyze data of flight deck thermal management system during at-sea test. EC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - Continue Aluminum Alloy Corrosion Mitigation Technologies - Develop coating and repair tools for final testing. - Continue Aluminum Alloy Corrosion Prediction Tool - Assess the robustness of the Degree of Sensitization (DoS) prediction algorithm and refine the algorithm for integration into the DoS detection tool. EC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Develop advanced marinized coatings for higher temperature service, marinized single crystal alloys, and disk coatings for oxidation and corrosion resistance. EC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Develop new materials mitigation technology for submarines. EC: EPE-FY16-01 ADVANCED TOPCOAT SYSTEM (ATS) - Initiate Advanced Topcoat Systems for Air Vehicle (ATS-AV) - Conduct formula optimization and modification development of advanced protective coating constituent combinations and preliminary material property validation towards TRL 6 formulas. FNC: EPE-FY19-04 Signature Management System (SMS) - Initiate SMS - Conduct applied research for submarine applications. ***FY 2018 Base Plans:*** FNC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Aluminum Alloy Corrosion Mitigation Technologies - Conduct a final assessment of the aluminum coating to minimize radiant heat build-up and an evaluation of aluminum repair tools. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-01 under a new Surface Warfare R-2 Activity) - Complete Aluminum Alloy Corrosion Prediction Tool - Conduct an assessment of aluminum corrosion prediction software integrated with the developed Degree of Sensitization (DoS) detection tools. FNC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Complete university hot corrosion and mechanical testing of materials and down-select the best materials for hardware development. (In FY19, this FNC Product will be realigned within this PE to SW-FY15-01 under a new Surface Warfare R-2 Activity) FNC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Evaluate new material mitigation technology. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-01 under a new Undersea Warfare R-2 Activity) FNC: EPE-FY16-01 ADVANCED TOPCOAT SYSTEM (ATS) - Continue Advanced Topcoat Systems for Air Vehicle (ATS-AV) - Conduct formula optimization and modification development of advanced protective coating constituent combinations and preliminary material property validation toward TRL 6 formulas. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-01 under a new Air Warfare R-2 Activity) FNC: EPE-FY19-04 Signature Management System (SMS) - Continue SMS - Continue applied research technology development for submarine applications. (In FY19, this FNC Product will be realigned within this PE to UW-FY19-01 under a new Undersea Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: EXPEDITIONARY MANEUVER WARFARE (EMW)	6.015	2.959	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total

Description: This R-2 Activity contains all Navy funded Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Expeditionary Maneuver Warfare (EMW) FNC Pillar. The EMW Pillar develops deliverable technologies that provide new capabilities in expeditionary maneuver warfare, including naval ground forces, with special emphasis on regular and irregular warfare in urban environments and combating terrorism.

The FY 2016 to FY 2017 decrease was due primarily to the planned ramp down of EMW-FY12-02 and the continuation of EMW-FY14-01 and EMW-FY16-01 in PE 0602131M.

The FY 2017 to FY 2018 decrease was due primarily to the completion and transition to acquisition of EMW-FY12-02 Future Joint Counter Radio-Controlled IED Electronic Warfare (JCREW) and the continuation of EMW-FY17-01 High Reliability DPICM Replacement (HRDR) in PE 0602131M Marine Corps Landing Force Technology, which was funded in this PE in FY17.

FY 2016 Accomplishments:
EC: EMW-FY12-02 FUTURE JOINT COUNTER RADIO-CONTROLLED IED ELECTRONIC WARFARE (JCREW)
- Continue Distributed Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (D-JCREW) - Refine radio frequency situational awareness techniques and distributed resource allocation on multiple ground-based Electronic Warfare systems by providing automated tactical-level distributed jamming.
- Continue Integrated Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (I-JCREW) - Enable the simultaneous transmission and reception of blue-force and Electronic Warfare communication waveforms by finalizing the components and techniques.

EC: EMW-FY13-01 AZIMUTH AND INERTIAL MICRO-ELECTRO-MECHANICA SYSTEM (MEMS) NAVIGATION SYSTEM
- Complete Micro-Electro-Mechanical System (MEMS) Inertial Navigation System - Complete optimization of MEMS sensor performance to reduce target location error in the Navigation System of hand-held targeting systems.

EC: EMW-FY14-01 SPECTRAL AND RECONNAISSANCE IMAGERY FOR TACTICAL EXPLOITATION (SPRITE)

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Automated Processing for Spectral Exploitation and Dissemination (APSED) - Develop an Electro-Optical (EO) and Hyper-Spectral Imagery (HSI) Image Processing architecture that includes EO to HSI cross-correlation and fusion, image archiving and retrieval, and exploitation product generation. - Complete Compact Wide Area Reconnaissance and Spectral Sensor (CWARSS) - Develop preliminary hardware design for a wide-area intelligence, surveillance and reconnaissance capability with simultaneous high spatial and spectral resolution. EC: EMW-FY16-01 DENSIFIED PROPELLANT FIRE FROM ENCLOSURE - CONFINED SPACE (FFE/CS) PROPULSION TECHNOLOGIES - Initiate Densified Propellant Fire From Enclosure - Confined Space (FFE/CS) Propulsion Technologies - Refine tungsten-propellant mix, grain dimensions and configuration, and the fabrication process to reach suitable rocket nozzle exit velocities and sound pressure levels.					
FY 2017 Plans: EC: EMW-FY12-02 FUTURE JOINT COUNTER RADIO-CONTROLLED IED ELECTRONIC WARFARE (JCREW) - Complete Distributed Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (D-JCREW) - Conduct final testing of Radio Frequency (RF) situational awareness techniques and distributed resource allocation on multiple ground-based Electronic Warfare (EW) systems by providing automated tactical-level distributed jamming. - Complete Integrated Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (I-JCREW) - Finalize the components and techniques to allow simultaneous transmission and reception of blue-force and Electronic Warfare (EW) communication waveforms. EC: EMW-FY16-01 DENSIFIED PROPELLANT FIRE FROM ENCLOSURE - CONFINED SPACE (FFE/CS) PROPULSION TECHNOLOGIES - Continued in PE 0602131M EC: EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT (HRDR) - Initiate High Reliability DPICM Replacement - Define High Reliability Dual-purpose Improved Conventional Munitions Master Safe and Arm Device hardware design and system architecture to transfer all arming, safing, and communication signals to/from the projectile's 56 sub-munition fuzes in under 6 seconds.					
FY 2018 Base Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT (HRDR) - Continued High Reliability DPICM Replacement in PE 0602131M. ***FY 2018 OCO Plans:*** N/A					
Title: FNC MANAGEMENT ***Description:*** This R-2 Activity includes the Science and Technology (S&T) analyses and studies required to take new Future Naval Capabilities (FNC) Program Enabling Capabilities (ECs) approved by the Technology Oversight Group and produce the detailed technology specifications and performance metrics needed to procure the component level technologies that must be developed and tested in order to deliver technology products to the acquisition community. This activity includes development and implementation of innovative and dynamically changing technology management business processes required to manage FNC investments supporting the naval capability pillars. ***FY 2016 Accomplishments:*** FNC MANAGEMENT - Continue FNC Management - New Start Preparations - Conduct technology analysis and studies to support the development and validation of technology performance specifications to ensure new enabling capabilities are able to commence execution in a timely manner. - Continue FNC Management - Support/OPS Analysis - Conduct warfighter sustainment Applied Research and analysis, including technology management of FNC investments supporting the naval capability pillars. ***FY 2017 Plans:*** FNC MANAGEMENT - Continue FNC Management - New Start Preparations - Conduct technology analysis and studies to support the development and validation of technology performance specifications to ensure new enabling capabilities are able to commence execution in a timely manner. - Continue FNC Management - Support/OPS Analysis - Conduct warfighter sustainment Applied Research and analysis, including technology management of FNC investments supporting the naval capability pillars. ***FY 2018 Base Plans:*** FNC MANAGEMENT	8.590	8.385	8.056	0.000	8.056

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue FNC Management - New Start Preparations - Conduct technology analysis and studies to support the development and validation of technology performance specifications to ensure new enabling capabilities are able to commence execution in a timely manner. - Continue FNC Management - Support/OPS Analysis - Conduct warfighter sustainment Applied Research and analysis, including technology management of FNC investments supporting the naval capability pillars. ***FY 2018 OCO Plans:*** N/A					
Title: FORCE HEALTH PROTECTION (FHP) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Force Health Protection (FHP) FNC pillar. The FHP Pillar develops deliverable technologies that provide new capabilities that provide Sailors and Marines with the best possible protection from operational threats by reducing morbidity and mortality when casualties occur. The FY 2016 to FY 2017 decrease was due primarily to the completion of FHP-FY11-01 and FHP-FY12-02, and the planned ramp-down of FHP-FY14-01 and FHP-FY14-03. The FY 2017 to FY 2018 decrease was due primarily to the completion of FHP-FY12-01 Automated Critical Care System (ACCS), which finished the development of the prototype hardware/software that monitors and maintains combat causalities with minimal human intervention, and the planned ramp down of 1) FHP-FY14-01 Acute Care Cover for Severely Injured Limbs (ACCSIL), which in FY18 is finishing the final elements of efficacy testing of innovative pharmaceutical solutions and novel materials that will enhance the bandage system for management of complex limb trauma, and 2) FHP-FY14-03 Blast Load Assessment Sense and Test (BLAST), which will finish S&T development in FY18 with the completion of algorithm predictions, the integration of data and power management technologies, and the validation of the neuro-functional assessment device that estimates Traumatic Brain Injury (TBI). ***FY 2016 Accomplishments:*** EC: FHP-FY11-01 MULTIFUNCTIONAL BLOOD SUBSTITUTE (MFBS) - Complete Multifunctional Blood Substitute (MFBS) - Finalize animal testing of optimal blood component mixture. EC: FHP-FY12-01 AUTOMATED CRITICAL CARE SYSTEM	8.331	5.730	4.308	0.000	4.308

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Automated Critical Care System (ACCS) - Formulate autonomous hardware and software system to monitor and maintain combat casualties with minimal human intervention during a 2-6 hour Casualty Evacuation scenario. EC: FHP-FY12-02 SAVING LIVES WITH EMERGENCY MEDICAL PERFLUOROCARBONS IN THE FIELD (SEMPER FI) FOR SEA, AIR & LAND DYSOXIA - Complete SEMPer Fi for Land Blast Kit - Determine window of therapeutic intervention and dosing with hypothermia for immediate treatment of blast overpressure in small and large animals, including injury to the brain or internal organs. EC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue Hypoxia Alert and Mitigation System - Conduct assembly of the sensor suite to detect and predict the onset of hypoxia and integrate mitigation strategies for individuals operating in high altitudes or Casualty Evacuation missions in unpressurized aircraft. EC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Continue Acute Care Cover for Severely Injured Limbs (ACCSIL) - Develop a fieldable wound cover comprising outer cover materials and an internal pharmaceutical coating that improves the clinical outcome of severe wounds. EC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Continue Algorithm - Collect experimental data for use in algorithm development that relates integrated blast intensity with cognitive impairment to predict the likelihood of brain injury after single or multiple blast exposures. - Continue Neuro-Functional Assessment Tool - Conduct experimental development of a non-psychometric device that detects and estimates the severity of traumatic brain injury. - Continue Sensor - Demonstrate a self-powered blast sensor in bench and laboratory testing for sensitivity to acceleration, pressure and impulse. ***FY 2017 Plans:*** EC: FHP-FY12-01 AUTOMATED CRITICAL CARE SYSTEM					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Automated Critical Care System (ACCS) - Complete technology development of hardware/software to monitor and maintain combat causalities with minimal human intervention during a 2-6 hour Casualty Evacuation (CASEVAC) scenario. EC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue Hypoxia Alert and Mitigation System - Continue efforts to predict the onset of hypoxia and integrate mitigation strategies for individuals operating in high altitudes or Casualty Evacuation missions in unpressurized aircraft. EC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Continue Acute Care Cover for Severely Injured Limbs (ACCSIL) - Conduct efficacy testing of innovative pharmaceutical solutions and novel materials for use in an enhanced bandage system for management of complex limb trauma. EC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Continue Blast Load Assessment: Sense and Test (BLAST) (formerly sensor, algorithm, and neurofunctional assessment tool) - Model the relationship between the injurious forces from blast incidents and the medical outcomes experienced by exposed warfighters, conduct validation of a Neuro-Functional Assessment Tool that provides a simple evaluation for Traumatic Brain Injury, and refine the self-powered, head-mounted, micro sensor being developed to detect the blast over-pressure and acceleration forces that cause traumatic brain injury. EC: FHP-FY16-01 INCAPACITATION PREDICTION FOR READINESS IN EXPEDITIONARY DOMAINS - AN INTEGRATED COMPUTATIONAL TOOL (I-PREDICT) - Initiate I-PREDICT - Begin development of an integrated, in-silico, morphomentrically-scalable model of the human being that estimates the injury response from external forces. ***FY 2018 Base Plans:*** FNC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue applied research efforts to exploit methods of detecting individual-specific challenges associated with combating casualties in warfighters operating at altitude.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Complete Acute Care Cover for Severely Injured Limbs (ACCSIL) - Conduct efficacy testing of innovative pharmaceutical solutions and novel materials that will enhance the bandage system for management of complex limb trauma. FNC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Complete Blast Load Assessment: Sense and Test (BLAST) - Finish algorithm predictions, integrate data and power management technologies, and validate the neuro-functional assessment device to estimate Traumatic Brain Injury. FNC: FHP-FY16-01 INCAPACITATION PREDICTION FOR READINESS IN EXPEDITIONARY DOMAINS - AN INTEGRATED COMPUTATIONAL TOOL (I-PREDICT) - Continue I-PREDICT - Develop an integrated, in-silico, morphometrically scalable model of the human being to estimate injury response from external forces (i.e., blunt, blast and vibratory forces). ***FY 2018 OCO Plans:*** N/A					
Title: FORCENET (FNT) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Forcenet (FNT) FNC Pillar. The FNT pillar develops deliverable technologies that provide new capabilities in Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), networking, navigation, sensors, decision support, cyber-space, intelligence, and space technologies that will provide the architectural framework for naval warfare in the information age. The FY 2016 to FY 2017 increase was due primarily to the planned ramp-up of FNT-FY15-02 and FNT-FY16-02, and the initiation of FNT-FY17-01, FNT-FY17-02, and FNT-FY17-04. The FY 2017 to FY 2018 decrease was due primarily to the ramp down of 1) FNT-FY15-02 Data Focused Naval Tactical Cloud, which will Mature Naval Tactical Cloud platform services for streaming, serial ingest and data management within an all source/adaptive data ecosystem, with additional focus on development of federated	31.085	42.489	41.368	0.000	41.368

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
query and analytic services, to include Expeditionary Warfare readiness and course-of-action recommendations, and 2) FNT-FY16-02 Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT), which will conduct high resolution sensor algorithm development. ***FY 2016 Accomplishments:*** EC: FNT-FY12-01 ADVANCED TACTICAL DATA LINK (ATDL) - Complete Mission-Based Waveform Controls & Networking - Develop Anti-Access/Area Denial enhancements to waveforms, along with advanced networking techniques, and validate performance through emulation. EC: FNT-FY12-02 AUTONOMOUS PERSISTENT TACTICAL SURVEILLANCE - Complete Autonomous Information-Based Surveillance Control - Complete algorithm development for information based Unmanned Aerial Vehicle (UAV) routing and pathing. - Complete Contextual Enterprise Information - Develop and demonstrate the analytical services framework, including enterprise exploitation services, for situation context between relevant theater sensor collections and exploitation products. - Complete Mobile Autonomous ISR to C2 Synchronization - Transition to MARCORSYSCOM a set of services that can automate the mapping of mission relevant information requirements to information fulfillments or deficits, and provide a sensor tasking recommendation to resolve deficits. EC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Continue EW Battle Management (EWBM) - Develop automation techniques for multiple Electronic Warfare systems across multiple ships, including network layer monitoring. EC: FNT-FY13-03 SILK THREAD - Continue Silk Thread Product 1 - Conduct applied research. - Continue Silk Thread Product 2 - Conduct applied research. EC: FNT-FY13-04 DETECTION AND FUSION FOR REMOTE SENSORS - Continue Adaptive Multi-Int Correlation & Identification (AMICA) - Research and analyze algorithms to enable cross-domain information fusion and optimize use of remote sensing assets. - Continue Detection & Classification Algorithms (DCA) - Research and analyze algorithms to provide enhanced detection and classification metrics and robust performance under stressing environmental conditions.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Continue Adaptive TCPED for ASW Services - Develop and evaluate the performance of methods that are context aware and determine the value of the information for an ASW mission. - Continue Data Exfiltration and Networked Platform Interaction - Develop digital radio components and waveforms directed toward host platforms with limited size, weight, and power and with the desired communication range and performance. EC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP) - Continue Advanced AEW Electronic Protection - Develop techniques to improve E-2D Advanced Hawkeye electronic protection. EC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud (formerly called Naval Tactical Cloud Analytics) - Conduct the data science activities to ingest all relevant data into the Naval Tactical Cloud to enable efficient decision support analytics for enhanced ASW, IAMD and EXW situational awareness and improved mission execution effectiveness. EC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Compact, Scalable Integrated RF (Compact-SIRF) - Develop scalable and modular, low Size, Weight and Power (SWaP) components and techniques for multi-function Radio Frequency processing on SWaP restricted platforms. - Continue Electronic Warfare Tactical Decision Aid (EW-TACAID) - Create an intuitive display with good user-centered design practices that has adaptive instructional content to suit an individual's aptitudes, learning preferences, and learning styles. - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Investigate techniques that facilitate the processing and high speed data conversion between digital processing and Radio Frequency collection systems. EC: FNT-FY16-01 BUGLE - Initiate Bugle - Develop algorithms that enable Battle Group communications. EC: FNT-FY16-02 COMBINED EO/IR SURVEILLANCE AND RESPONSE SYSTEM (CESARS)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Investigate multiband laser, window, and sensing technologies as well as advanced countermeasure techniques for shipboard defense. - Initiate Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Investigate small pixel Mid-Wave Infrared (MWIR) Focal Plane Array (FPA) technologies and innovative approaches for seamless stitching of multiple FPAs to create large format, high pixel-count imagers.					
FY 2017 Plans: EC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Continue EW Battle Management (EWBM) - Develop automated queuing/attack techniques and tactical use of cross domain data for multiple Electronic Warfare (EW) systems across multiple ships. EC: FNT-FY13-03 SILK THREAD - Continue Silk Thread Product 1 - Conduct applied research. - Continue Silk Thread Product 2 - Conduct applied research. EC: FNT-FY13-04 DETECTION AND FUSION FOR REMOTE SENSORS - Complete Adaptive Multi-Int Correlation & Identification (AMICA) - Research and analyze algorithms to enable cross-domain information fusion and optimization of theater and tactical battlespace assets to conduct anti-surface warfare. - Complete Detection & Classification Algorithms (DCA) - Research and analyze algorithms to provide enhanced detection and classification metrics and robust performance under stressing environmental conditions. EC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Continue Adaptive TCPED for ASW Services - Develop advanced techniques for automated, high accuracy, low error rate, adaptive processing. - Continue Data Exfiltration and Networked Platform Interaction - Integrate and conduct initial demonstration of the radio components and waveforms in a host platform in a simulated environment. EC: FNT-FY14-03 EXCHANGE OF ACTIONABLE INFORMATION AT THE TACTICAL EDGE (EAITE)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue from PE 0602131M Actionable Information Tactical Applications from PE 0602131M - Develop natural language processing lexicon algorithms to enable machine understanding of a user defined information requirement. EC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP) - Continue Advanced AEW Electronic Protection - Develop techniques to improve Advanced Hawkeye (E2-D) electronic protection capability. EC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud - Mature Naval Tactical Cloud platform services for streaming, serial ingest and data management within an all source/adaptive data ecosystem, with additional focus on development of federated query and analytic services, to include Expeditionary Warfare readiness and course-of-action recommendations. EC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Investigate new techniques/functionality focusing on Electronic Warfare/Intelligence, Surveillance, Reconnaissance/Electronic INTelligence (EW/ISR/ELINT) collection and processing techniques for the modular functionality payload. - Continue Compact, Scalable Integrated RF (Compact-SIRF) - Develop a modular payload bay and modular Radio Frequency (RF) front end bay for small/medium sized unmanned undersea vehicles. - Continue Electronic Warfare Tactical Decision Aid (EW-TACAID) - Develop new user interface concepts to mitigate shortcomings and issues associated with the Electronic Warfare environment and develop a deeper understanding of the nature of the Electronic Warfare domain content that is most suited for instruction via adaptive training. EC: FNT-FY16-01 BUGLE - Continue Bugle - Develop algorithms that enable battle group communications in communication-challenged, forward-deployed environments. EC: FNT-FY16-02 Combined EO/IR Surveillance and Response System (CESARS) - Continue Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Begin high fidelity tracking algorithm development.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Begin high resolution sensor algorithm development. EC: FNT-FY17-01 COMMUNICATIONS AND INTEROPERABILITY FOR INTEGRATED FIRES (CIIF) - Initiate Communications as a Service (CaaS) - Develop distributed optimization algorithms and Quality of Service (QoS) protocols for heterogeneous data link networks. - Initiate Mission-Based Networking for DDS (MiND) - Develop forward error correction and directional networking algorithms. EC: FNT-FY17-02 SUBMARINE SIMULTANEOUS TRANSMIT AND RECEIVE (SUBSTAR) - Initiate Submarine Simultaneous Transmit and Receive (SubSTAR) - Develop a submarine broadband antenna enabling simultaneous transmit and receive capability. EC: FNT-FY17-04 RESILIENT HULL/INFRASTRUCTURE MECHANICAL & ELECTRICAL SECURITY (RHIMES) - Initiate SCRAM - Develop software algorithms that protect naval Hull, Mechanical and Electrical (HM&E) systems against cyber threats. - Initiate SCAMM - Develop information shaping cyber capabilities for tactical platforms. FNC: FNT-FY18-02 NON-GPS AIDED POSITIONING NAVIGATION AND TIMEKEEPING FOR SURFACE AND SUBSURFACE (NoGAPSS) - Initiate Adaptive Broadband Navigation Sonar System (ABNSS) - Begin development of a modular processing framework, algorithms, and software for broadband velocity estimation. FNC: FNT-FY18-05 ADVANCED COORDINATION TECHNIQUES FOR DISTRIBUTED EW - Initiate Coordinated Radio Frequency EW (CRFEW) - Conduct an analysis of precision geo-location and coordinated engagement techniques to support netted sensor battlespace emitter geo-location and coordinated Electronic Warfare (EW) operations. - Initiate Next Generation Surface Electronic Warfare User Interface - Conduct a task analysis of surface EW to inform the user requirements of single and cross-ship sensor correlation, disambiguation and fixing, and tactical decision making.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate Propagation Channel Assessment and Prediction (PCAP) - Analyze real-time techniques for assessing radio frequency propagation channels in support of naval operations.					
FY 2018 Base Plans: FNC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Complete EW Battle Management (EWBM) - Integrate combat system data with cross domain data to automate tactical Electronic Warfare (EW) decision making across multiple ships. FNC: FNT-FY13-03 SILK THREAD - Complete Silk Thread Product 1 - Finish applied research efforts for this classified program. - Complete Silk Thread Product 2 - Finish applied research efforts for this classified program. FNC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Complete Adaptive TCPED for ASW Services - Complete the development of advanced techniques for automated high accuracy, low error rate, adaptive processing. - Complete Data Exfiltration and Networked Platform Interaction - Integrate radio components and waveforms in a host platform. FNC: FNT-FY14-03 EXCHANGE OF ACTIONABLE INFORMATION AT THE TACTICAL EDGE (EAITE) - Continue Actionable Information Tactical Applications - Research and design natural language processing algorithms to enable machine understanding of an information requirement. (In FY19, this FNC Product will be realigned within this PE to IW-FY14-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP) - Continue Advanced AEW Electronic Protection - Implement real-time AEW Electronic Protection improvements within the airborne prototype. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-01 under a new Air Warfare R-2 Activity) FNC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud - Perform applied research in machine learning analytics to support automated enemy course-of-action predictions based on all-source intelligence for integrated fires and					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
integrated air and missile defense. (In FY19, this FNC Product will be realigned within this PE to IW-FY15-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Compact, Scalable Integrated RF (Compact-SIRF) - Perform laboratory effectiveness testing to evaluate the RF design, which includes communications, cyber, information operations and electronic warfare operational performance requirements. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-02 under a new Undersea Warfare R-2 Activity) - Complete Electronic Warfare Tactical Decision Aid (EW-TACAID) - Conduct analyses of efficient operator interfaces in support of netted sensor and coordinated EW operations. - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Conduct laboratory analysis of temporal, spectral and resource allocation management techniques for optimized resource sharing. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-02 under a new Undersea Warfare R-2 Activity) FNC: FNT-FY16-01 BUGLE - Continue Bugle - Continue applied research efforts supporting advanced waveforms. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY16-02 COMBINED EO/IR SURVEILLANCE AND RESPONSE SYSTEM (CESARS) - Continue Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Finalize development of the high resolution sensor algorithms, laser hardware, and countermeasure algorithms and techniques. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-03 under a new Information Warfare R-2 Activity) - Continue Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Develop, assess and analyze algorithms, noise performance, resolution and sensitivity technology, and software for data capture, recording, processing and display. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-03 under a new Information Warfare R-2 Activity) FNC: FNT-FY17-01 COMMUNICATIONS AND INTEROPERABILITY FOR INTEGRATED FIRES (CIIF) - Continue Communications as a Service (CaaS) - Validate and test distributed optimization algorithms and quality-of-service protocols. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-01 under a new Information Warfare R-2 Activity)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Mission-Based Networking for DDS (MiND) - Conduct simulation and system engineering of waveform coding/modulation, adaptive link management and Data Distribution System (DDS) networking/quality of service. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-01 under a new Information Warfare R-2 Activity) FNC: FNT-FY17-02 SUBMARINE SIMULTANEOUS TRANSMIT AND RECEIVE (SUBSTAR) - Continue Submarine Simultaneous Transmit and Receive (SubSTAR) - Develop and prototype initial broadband simultaneous transmit and receive antenna designs. (In FY19, this FNC Product will be realigned within this PE to UW-FY17-01 under a new Undersea Warfare R-2 Activity) FNC: FNT-FY17-04 RESILIENT HULL/INFRASTRUCTURE MECHANICAL & ELECTRICAL SECURITY (RHIMES) - Continue SCAMM - Develop information sharing capabilities for tactical platforms. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-02 under a new Information Warfare R-2 Activity) - Continue SCRAM - Develop resilient software for integrated control systems, including those without redundant processors. (In FY19, this FNC Product will be realigned within this PE to SW-FY17-01 under a new Surface Warfare R-2 Activity) FNC: FNT-FY18-04 NANOSAT COMMUNICATIONS FOR A2AD OPERATIONS - Initiate Nanosat Communications Payloads - Develop and prototype a nanosat communication payload in UHF- and X-bands. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-02 under a new Information Warfare R-2 Activity) - Initiate Shipboard Integration - Develop and integrate shipboard networking in UHF- and X-bands with Digital Mobile Radio and Navy multiband terminal. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY18-05 ADVANCED COORDINATION TECHNIQUES FOR DISTRIBUTED EW - Continue Coordinated Radio Frequency EW (CRFEW) - Continue analyzing precision geo-location and coordinated engagement techniques to support netted sensor battlespace emitter geo-location and coordinated Electronic Warfare (EW) operations. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) - Continue Next Generation Surface Electronic Warfare User Interface - Continue the analysis of surface EW to inform user requirements of single and cross-ship sensor correlation, disambiguation and fixing, and tactical					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
decision making. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) - Continue Propagation Channel Assessment and Prediction (PCAP) - Continue analyzing real-time techniques for assessing radio frequency propagation channels in support of naval operations. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: POWER AND ENERGY (P&E) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Power and Energy (P&E) FNC pillar. The P&E Pillar develops deliverable technologies that provide new capabilities in energy security, efficient power and energy systems, high energy and pulse power. The FY 2016 to FY 2017 increase was due to the initiation of P&E-FY17-02. ***FY 2016 Accomplishments:*** EC: P&E-FY12-01 RENEWABLE-SUSTAINABLE EXPEDITIONARY POWER - Complete Renewable Thermal Engine - Finish final design and fabrication of full-scale tactical power system prototype, incorporating all features to be exercised in a TRL 6 demonstration. EC: P&E-FY12-03 LONG ENDURANCE UNDERSEA VEHICLE PROPULSION - Continue Air Independent Propulsion System - Conduct final design of Phase II fuel cell energy system and coordinate test planning. EC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS - Continue High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Conduct modelling, simulation and cost analyses of Phase II circuit protection designs and prepare test and safety plans for Phase II circuit protection devices. EC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY	6.494	11.795	11.038	0.000	11.038

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Compact High Density Tactical Energy Storage - Develop tactical multifunction Energy Storage Module subcomponent technology and designs. - Continue Multi-Function High Density Shipboard Energy Storage - Develop final designs, which integrate ship energy storage module component technologies into a subscale system, and develop subscale system test plans. ***FY 2017 Plans:*** EC: P&E-FY12-03 LONG ENDURANCE UNDERSEA VEHICLE PROPULSION - Complete Air Independent Propulsion System - Conduct final design of Phase II fuel cell energy system and coordinate test planning. EC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS - Continue High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Transition the modeling and simulation and technology development effort from an initial 1kV voltage level to the final 20kV voltage level. EC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY - Continue Multi-Function High Density Shipboard Energy Storage - Demonstrate the capability of subscale energy storage component technologies and perform an analysis of the ship impact of multifunction energy storage with high pulse loads. - Continue Compact High Density Tactical Energy Storage - Complete development of tactical multifunction Energy Storage Module subcomponent technology and continue analysis of tactical multifunction Energy Storage Module technology designs. EC: P&E-FY17-02 TORPEDO ADVANCED PROPULSION SYSTEM (TAPS) - Initiate Torpedo Advanced Propulsion System (TAPS) - Initiate safety analyses and system modeling concepts for each technology identified in the Analysis of Alternatives (AoA). ***FY 2018 Base Plans:*** FNC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS - Complete High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Transition a knowledge product with relevant voltage, current and protection ratings to the acquisition sponsor.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY - Complete Compact High Density Tactical Energy Storage - Complete module subsystem modeling, analysis, and development. - Continue Multi-Function High Density Shipboard Energy Storage - Conduct an analysis of the ship impact of multifunction energy storage technology with high pulse loads. (In FY19, this FNC Product will be realigned within this PE to SW-FY15-02 under a new Surface Warfare R-2 Activity) FNC: P&E-FY17-02 TORPEDO ADVANCED PROPULSION SYSTEM (TAPS) - Continue Torpedo Advanced Propulsion System (TAPS) - Complete safety and cost analyses of the technology solutions being developed. (In FY19, this FNC Product will be realigned within this PE to UW-FY17-02 under a new Undersea Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: SEA BASING (BAS) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Sea Basing (BAS) FNC pillar. The BAS Pillar develops deliverable logistics, shipping and at-sea transfer technologies that provide new capabilities for projecting expeditionary force from the sea base and providing sea based joint operational independence through improved connector, at-sea transfer and shipboard logistical capabilities. ***FY 2016 Accomplishments:*** EC: EC: BAS-FY11-01 CONNECTORS AND THE SEA BASE - Complete Environmental Ship Motion Forecasting - Develop environmental and ship motion sensor and forecasting components. ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:***	0.063	0.000	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: SEA SHIELD (SHD)	50.619	42.097	40.074	0.000	40.074

Description: This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Sea Shield (SHD) FNC pillar. The SHD Pillar develops deliverable technologies that provide new capabilities in theater air and missile defense, anti-submarine warfare, mine countermeasures, defensive surface warfare, global defensive assurance, anti-terrorism, and fleet/force protection.

The FY 2016 to FY 2017 decrease was due primarily to the completion of SHD-FY10-01, SHD-FY10-03, SHD-FY11-01, SHD-FY12-01 and SHD-FY12-03, the planned ramp-down of SHD-FY13-07, SHD-FY14-02, SHD-FY14-04, SHD-FY14-08 and SHD-FY15-07, and the movement of SHD-FY16-OSD out of the FNC Program into PE 0602782N.

The FY 2017 to FY 2018 decrease was due primarily to the ramp down of 1) SHD-FY15-07 Hyper Velocity Projectile, which will demonstrate the component technology required to support a hypervelocity launch with common interfaces for powder gun and railgun launch conditions, 2) SHD-FY16-05 Surface Ship Periscope Detection and Discrimination (SSPDD), which will develop specialized interface hardware for technology components, and 3) SHD-FY16-06 Next Generation Airborne Passive System (NGAPS), which will develop algorithms and hardware for field communications, control, health monitoring, mission planning and contact separation and correlation.

FY 2016 Accomplishments:
EC: SHD-FY10-01 ANTI-SHIP MISSILE DEFENSE TECHNOLOGIES
- Complete Enhanced Lethality Guidance Algorithms (ELGA) - Optimize the guidance algorithm to increase the probability of kill against an expanded threat set.
- Complete Enhanced Maneuverability Missile Airframe (EMMA) - Mature the technologies associated with the dual pulse rocket motor and integrated thrust vector control, incorporating risk reduction schemes.

EC: SHD-FY10-03 ADVANCED SONAR TECHNOLOGY FOR HIGH CLEARANCE RATE MCM
- Complete Long Range LFBB Sonar (AUV Platform Option) - Finalize software configuration and perform final data collection.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: SHD-FY11-01 TORPEDO COMMON HYBRID FUZING SYSTEM - Complete Torpedo Common Hybrid Fuzing System - Conduct final at-sea data collection, testing and demonstration of Technology Readiness Level #6. EC: SHD-FY12-01 FORCE LEVEL RADAR RESOURCE MANAGEMENT FOR INTEGRATED AIR AND MISSILE DEFENSE (IAMD) - Complete Radar Resource Manager for IAMD - Refine, mature, and test advanced algorithms for ballistic missile defense track coordination. EC: SHD-FY12-03 SONAR AUTOMATION - Complete Active Sonar Automation - Evaluate and deliver algorithms to improve active sonar operator performance in detecting submarines while reducing false contact rates. - Complete Passive Sonar Automation - Evaluate and deliver algorithms that improve Passive Sonar operator performance against quiet submarines in the presence of clutter. EC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Continue Compact Modular Sensor-Processing Suite (CMSS) - Achieve low False Alarm Rate with advanced data fusion techniques. EC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR - Continue Cooperative Networked Radar - Develop techniques for cross platform radar operation. EC: SHD-FY13-05 HIGH ALTITUDE ASW (HAASW) FROM THE P-8 - Continue Next Generation Multistatic Active Capability (NGMAC) - Develop algorithms for use in the Multistatic Active Capability system that improve performance, reduce operator workload, and allow for use in all ocean environments. - Complete Unmanned Targeting Air System (UTAS) - Update vehicle noise models and coordinate with Magnetic Anomaly Detection algorithms. EC: SHD-FY13-07 USV PAYLOADS FOR SINGLE SORTIE MINE COUNTERMEASURES - Continue MCM Payload Automation for Data Analysis - Develop probabilistic Enemy Course of Action models and update algorithms supporting Net-centric Sensor Analysis for MIW (NSAM).					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue MCM Payload Automation for Planning - Develop probabilistic Enemy Course of Action models and update algorithms supporting Mine-warfare Environmental Decision-Aid Library (MEDAL). - Continue Single Sortie MCM Detect-to-Engage Payload - Develop the architecture, command and control algorithms, planning algorithms, and hardware design options. - Continue USV-based Mine Neutralization - Develop low-cost sensing, navigation, and battle damage assessment solutions, algorithms, and associated autonomy technology. EC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue Concept C Countermeasure - Commence array re-design to correct technical issues discovered during testing. - Continue ATT Timeline Compression (ATTTC) - Develop algorithms and real time code for guidance enhancements. - Complete HVU Mounted Sonar - Develop an array hull-mount and baffling mechanism, and model the resultant acoustic performance. EC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Continue Autonomous Threat Detection and Localization - Model system node positioning algorithms and mission planning improvements, and conduct simulation testing. - Continue Remote Command & Control - Model and assess improved integrated system communications configuration protocols and algorithms. - Continue Tactical Positioning & Fire Control - Develop an improved sensor node architecture and conduct evaluation modeling of detection, classification, localization and targeting capabilities. EC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S (formerly Terminator E, S and R) - Develop fire control algorithms for implementation in the Ship Self-Defense System (SSDS). EC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Initiate MCM Task Force Planning - Develop algorithmic approaches for optimal tailoring of heterogeneous MCM assets. - Initiate Expeditionary MCM Automated Data Analysis - Investigate the applicability of physics-based approaches to performance estimation.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Continue Hyper Velocity Projectile - Demonstrate the component technology required to support a hypervelocity launch and common interfaces for powder gun and railgun launch conditions. EC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Initiate Ship-launched EW Extended Endurance Decoy (SEWEED) - Develop preliminary vehicle, payload, rocket, and launcher conceptual designs and sizing. EC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Initiate Surface Ship Periscope Detection and Discrimination (SSPDD) - Develop specialized interface hardware for technology components. EC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS) - Initiate Next Generation Airborne Passive System (NGAPS) - Develop an 'A-size' deep, long-duration, passive sonobuoy for area surveillance that takes advantage of Reliable Acoustic Path detection against modern quiet submarines and is tethered to a surface float containing a radio. EC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Initiate Softkill Performance and Real-Time Assessment (SPARTA) - Develop and establish design criteria, system requirements and software requirements. EC: SHD-FY16-OSD MODULAR UNDERSEA EFFECTORS (MUSE) - Initate Modular UnderSea Effectors (MUSE) - Develop acoustic propagation modeling, algorithms for tracking and tracking, and algorithms to exploit the acoustic communications environment.					
FY 2017 Plans: EC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Continue Compact Modular Sensor-Processing Suite (CMSS) - Use additional environmental data to validate advanced data fusion techniques and low False Alarm Rates. EC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Cooperative Networked Radar - Develop software algorithms and techniques for cross-platform radar operation that deliver enhanced sensitivity. EC: SHD-FY13-05 HIGH ALTITUDE ASW (HAASW) FROM THE P-8 - Complete Next Generation Multistatic Active Capability (NGMAC) - Finish applied research efforts in support of a demonstration of the Next Generation Multistatic Active Capability sonobuoys in a relevant at sea Navy environment. EC: SHD-FY13-07 USV PAYLOADS FOR SINGLE SORTIE MINE COUNTERMEASURES - Complete USV-Based Mine Neutralization - Finalize low-cost sensing and navigation solutions, algorithm development, and associated autonomy. - Complete Single Sortie MCM Detect-to-Engage Payload - Finalize command and control technology and planning algorithms, and implement them on the MCM hardware. - Complete MCM Payload Automation for Data Analysis - Finish algorithm development and description. - Complete MCM Payload Automation for Planning - Finalize risk calculation software integration and documentation. EC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue ATT Timeline Compression (ATTTC) - Modify the algorithms based on test results. - Continue Concept C Countermeasure - Continue with array re-design to correct technical issues discovered during testing. EC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Continue Tactical Positioning & Fire Control - Develop enhanced fire control solution algorithms and technology for advanced minefield planning. - Continue Autonomous Threat Detection and Localization - Model improved sensor node algorithms and updated software. - Continue Remote Command & Control - Develop final gateway buoy design and adaptive acoustic communications protocols. EC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S (formerly Terminator E, S and R) - Develop fire control algorithms for implementation in the Ship Self-Defense System (SSDS).					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Continue MCM Task Force Planning - Formulate core algorithms that provide mathematical foundation for effects based application of risk, re-planning, and incorporation of legacy and emerging MCM systems. - Continue Expeditionary MCM Automated Data Analysis - Develop performance estimation and environmentally-adaptive Automatic Target Recognition (ATR) algorithms. EC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Continue Hyper Velocity Projectile - Demonstrate the component technology required to support a hypervelocity launch with common interfaces for powder gun and railgun launch conditions. EC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Continue Ship-launched EW Extended Endurance Decoy (SEWEED) - Develop preliminary vehicle, payload, rocket, and launcher conceptual designs and sizing. EC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Continue Surface Ship Periscope Detection and Discrimination (SSPDD) - Develop specialized interface hardware for technology components. EC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS) - Continue Next Generation Airborne Passive System (NGAPS) - Develop Algorithms and hardware for field communications, control, health monitoring, mission planning and contact separation and correlation. EC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Continue Softkill Performance and Real-Time Assessment (SPARTA) - Develop and establish design criteria, system requirements, and software requirements. EC: SHD-FY16-OSD MODULAR UNDERSEA EFFECTORS (MUSE) - Continued in PE 0602782N EC: SHD-FY17-02 AUTONOMOUS UNMANNED SURFACE VEHICLES FOR MINE WARFARE (MIW) - Initiate Autonomous Situational Awareness and Hazard Avoidance System for USVs - Develop perception and route-planning autonomous control for Unmanned Surface Vehicles (USVs).					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate High Temperature Superconducting (HTS) Magnetic Influence Sweep Payload for USVs - Develop superconducting technology for the mine influence sweep payload on Unmanned Surface Vehicles (USVs). - Initiate Underway Refueling and Data Transfer for USVs and RMMVs - Develop technology for underway refueling of Unmanned Surface Vehicles (USVs) and Remote Multi-Mission Vehicles (RMMVs) and conduct data transfer from an RMMV. EC: SHD-FY17-05 DEEP RELIABLE ACOUSTIC PATH EXPLOITATION SYSTEM (DRAPES) - Initiate Deep Reliable Acoustic Path Exploitation System (DRAPES) - Develop algorithms for undersea communications, health monitoring, and contact separation and correlation.					
FY 2018 Base Plans: FNC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Complete Compact Modular Sensor-Processing Suite (CMSS) - Finish developing an extension of the software and algorithms to include interaction with the seabed necessary for the new three dimensional cameras. FNC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR - Complete Cooperative Networked Radar - Finish developing software algorithms and techniques for cross-platform radar operation that deliver enhanced sensitivity. FNC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue ATT Timeline Compression (ATTTC) - Continue development of bi-static and acoustic communication algorithms. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-03 under a new Surface Warfare R-2 Activity) - Continue Concept C Countermeasure - Conduct electronic subsystem software integration. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-03 under a new Surface Warfare R-2 Activity) FNC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Complete Autonomous Threat Detection and Localization - Finalize and document algorithm development and detection, classification, localization, and tracking performance. - Complete Remote Command & Control - Finalize and document algorithm development and command and control functionality.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Tactical Positioning & Fire Control - Finalize and document system autonomy and fire solution algorithms. FNC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S - Develop fire control algorithms for implementation in the Ship Self-Defense System (SSDS). (In FY19, this FNC Product will be realigned within this PE to SW-FY14-04 under a new Surface Warfare R-2 Activity) FNC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Continue Expeditionary MCM Automated Data Analysis - Develop fusion algorithms for low frequency sonar and acoustic color with high frequency imaging systems. (In FY19, this FNC Product will be realigned within this PE to EMW-FY15-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue MCM Task Force Planning - Refine re-planning algorithms and integrate them with algorithms for the effects-based application of risk. (In FY19, this FNC Product will be realigned within this PE to EMW-FY15-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) FNC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Complete Hyper Velocity Projectile - Demonstrate the component technology required to support a hypervelocity launch and develop common interfaces for powder gun and railgun launch conditions. FNC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Continue Ship-launched EW Extended Endurance Decoy (SEWEED) - Conduct design development of the demonstrator vehicle and payload bay, and continue documentation of design and interface control. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-04 under a new Information Warfare R-2 Activity) FNC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Continue Surface Ship Periscope Detection and Discrimination (SSPDD) - Continue development of the generation 2.5 government-reference prototype sensor, data fusion system, and pre-planned product improvement options. FNC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Next Generation Airborne Passive System (NGAPS) - Model and test algorithms and hardware for field communications, control, health monitoring, mission planning and contact separation/correlation. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-02 under a new Air Warfare R-2 Activity) FNC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Continue Softkill Performance and Real-Time Assessment (SPARTA) - Develop and establish design criteria, system requirements, and software requirements. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-05 under a new Information Warfare R-2 Activity) FNC: SHD-FY17-02 AUTONOMOUS UNMANNED SURFACE VEHICLES FOR MINE WARFARE (MIW) - Continue Autonomous Situational Awareness and Hazard Avoidance System for USVs - Develop autonomous situational awareness and hazard avoidance system components for Unmanned Surface Vehicles (USVs) that enable avoidance of fixed and moving hazards, while providing the ability to regain track and revisit missed areas using a low bandwidth control link. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue High Temperature Superconducting (HTS) Magnetic Influence Sweep Payload for USVs - Develop magnetic, mine-influence, sweep system technology components that can be integrated on an Unmanned Surface Vehicle (USV) enabling a sweep capability that is self-contained and capable of unmanned tactical operations. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue Underway Refueling and Data Transfer for USVs and RMMVs - Develop automated underway refueling technology for Unmanned Surface Vehicles (USVs) and unmanned semisubmersible vehicles that is capable of conducting unmanned/automated refueling operations and data download/upload in up to sea state 3, away from a host refueling ship. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) FNC: SHD-FY17-05 DEEP RELIABLE ACOUSTIC PATH EXPLOITATION SYSTEM (DRAPES) - Continue Deep Reliable Acoustic Path Exploitation System (DRAPES) - Develop algorithms for undersea communications, health monitoring, and contact separation/correlation. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-03 under a new Information Warfare R-2 Activity) FNC: SHD-FY18-08 FORCE-LEVEL INTEGRATED FIRES REAL-TIME ENGAGEMENT COORDINATION AND PERFORMANCE ESTIMATION (FIRECAPE)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate FIRECAPE Algorithms - Begin development of performance estimation and coordination algorithms and validate their performance using Monte Carlo analysis against complex threat raids. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-04 under a new Information Warfare R-2 Activity) FNC: SHD-FY19-07 (IW-FY19-03) Theater ASW Commander Battle Management (TASWC BaM TDA) - Initiate TASWC Battle Management TDA - Establish protocol and setup for Measures of Effectiveness analysis. (In FY19, this FNC Product will be realigned within this PE to IW-FY19-03 under a new Information Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: SEA STRIKE (STK) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE. The Sea Strike (STK) FNC pillar develops deliverable technologies that provide new capabilities in power projection and deterrence, precise and persistent offensive power, weapons, aircraft, and expeditionary warfare. The FY 2017 to FY 2018 decrease was due primarily to the ramp down of 1) STK-FY13-03 Anti-Surface Warfare (ASuW) Weapon Upgrade, which will develop algorithms, 2) STK-FY15-02 Helicopter Active RPG Protection (HARP), which will design and develop prototype concepts and new processes for a Rocket Propelled Grenade (RPG) hard-kill defense for rotorcraft, and 3) STK-FY17-04 ALPO, which will continue developing advanced signal processing system algorithms for the advanced signal processing system; and the completion of 1) STK-FY14-01 Bank Shot, which will continue to study passive sensor phenomenology. ***FY 2016 Accomplishments:*** EC: STK-FY12-01 SUBMARINE SURVIVABILITY - ELECTRONIC WARFARE - Complete Coherent Electronic Attack for Submarines (CEAS) - Conduct experiments of the waveform interactions and spectrum processing that occurs between advanced Electronic Warfare and radar systems in order to assess the effectiveness of new electronic support detection and electronic attack countermeasure techniques. EC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID	41.184	31.992	28.324	0.000	28.324

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Long Range Find, Fix and ID - Develop algorithms for moving maritime Radio Frequency identification. EC: STK-FY13-02 HOSTILE FIRE (HF) SUPPRESSION - Complete Hostile Fire Suppression System - Demonstrate real-time muzzle flash detection and tracking. EC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Continue Anti-Surface Warfare (ASuW) Weapon Upgrade - Develop relevant algorithms. EC: STK-FY13-04 AIM-9X ENABLERS (AXE) - Continue SMOKE - Evaluate and model advanced kinematic technology improvements for a future Air-to-Air missile. EC: STK-FY14-01 BANK SHOT - Bank Shot - Study and understand passive sensor phenomenology. EC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Continue Collaborative Anti-Surface Warfare Engagement (CASE) - Design, develop, and improve weapon-to-weapon communications, coupled with algorithms for limited weapon autonomy, that address the surface warfare mission area. - Continue Collaborative Electronic Attack (CEA) - Develop adaptable Electronic Warfare mission prioritization and collaborative classification algorithms to enable U.S. Naval forces the ability to conduct Anti-Surface Warfare. EC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Develop algorithms and techniques to improve synthetic aperture radar electronic protection. EC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Design and develop prototype concepts and new processes for a Rocket Propelled Grenade (RPG) hard-kill defense for rotorcraft.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Multi-Spectral EO/IR Seeker Defeat - Conduct modeling and simulation to define countermeasure sources and expendables requirements for rotary wing aircraft defense against advanced multi-spectral Electro-Optical/Infrared (EO/IR) Man Portable Air Defense Systems (MANPADS). EC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Downselect an autonomy suite prototype. - Continue MUHV Sensors, Navigation and Guidance - Conduct fiber optic development. EC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Continue Extended-Range Targeting (E-RAT) - Design, develop, and improve prototypes and processes that address extended range targeting and fire control. EC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM) - Initiate Reactive Electronic Attack Measures (REAM) - Develop signal detection and classification techniques that can recognize new and agile radar threats. EC: STK-FY17-04 ALPO - Continue ALPO - Commence development of advanced signal processing system algorithms.					
FY 2017 Plans: EC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID - Continue Long Range Find, Fix and ID - Develop algorithms for achieving Radio Frequency (RF) identification of moving maritime contacts. EC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Continue Anti-Surface Warfare (ASuW) Weapon Upgrade - Refine the subsystem design and development plan. EC: STK-FY13-04 AIM-9X ENABLERS (AXE) - Continue SMOKE - Evaluate and model advanced kinematic technology improvements for a future Air-to-Air missile. EC: STK-FY14-01 BANK SHOT					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Bank Shot - Evaluate and model sensor phenomenology. EC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Continue Collaborative Anti-Surface Warfare Engagement (CASE) - Design, develop, and improve weapon-to-weapon communications, coupled with algorithms for limited weapon autonomy that address the surface warfare mission area. - Continue Collaborative Electronic Attack (CEA) - Develop and prototype highly synchronized collaborative multiple platform Electronic Attack (EA) techniques. EC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Develop of algorithms and techniques to improve synthetic aperture radar electronic protection. EC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Design and develop prototype concepts and new processes for a Rocket Propelled Grenade (RPG) hard-kill defense for rotorcraft. - Continue Multi-Spectral EO/IR Seeker Defeat - Develop Infra-Red CounterMeasures (IRCM) Electro-Optic/ Infra-Red (EO/IR) techniques for both flare and jammer, used alone and in combination, while utilizing Navy developed Hardware-In-The-Loop (HITL). EC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Develop autonomy algorithms for mission planning, waypoint navigation, and vehicle health assessment. - Continue MUHV Sensors, Navigation and Guidance - Develop multiband and hybrid sonar, inertial navigation, and fiber optic systems. EC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Continue Extended-Range Targeting (E-RAT) - Design, develop, and improve prototypes and processes that address extended range targeting and fire control. EC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Reactive Electronic Attack Measures (REAM) - Adapt machine learning algorithms from the Adaptive Radar Countermeasures (ARC) program to support offensive Electronic Warfare Support (ES) and Electronic Attack (EA) capabilities, including integrated unknown emitter characterization and response. EC: STK-FY17-04 ALPO - Continue ALPO - Continue developing advanced signal processing system algorithms for the advanced signal processing system. FNC: STK-FY18-01 PRECISION ELECTRONIC ATTACK TECHNOLOGIES (PEAT) - Initiate Multi-platform Retro-directive EW - Conduct analysis of synchronized Electronic Warfare (EW) effects across multiple platforms and EW systems. - Initiate Single Platform Coherent Arrays - Conduct analysis of synchronized EW effects across intra-platform EW components.					
FY 2018 Base Plans: FNC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID - Complete Long Range Find, Fix and ID - Improve Long Range ID algorithm performance within unanticipated maritime phenomenology. FNC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Complete Anti-Surface Warfare (ASuW) Weapon Upgrade - Develop and verify algorithms for Phase II. FNC: STK-FY13-04 AIM-9X ENABLERS (AXE) - Complete SMOKE - Evaluate and model advanced kinematic technology improvements for a future air-to-air missile. FNC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Complete Collaborative Anti-Surface Warfare Engagement (CASE) - Design, develop, and improve weapon-to-weapon communications, coupled with algorithms for limited weapon autonomy addressing the surface warfare mission area. - Continue Collaborative Electronic Attack (CEA) - Perform applied research in cognitive electronic warfare to produce next generation electronic jamming effects. (In FY19, this FNC Product will be realigned within this PE to IW-FY14-03 under a new Information Warfare R-2 Activity)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Implement real-time electronic protection improvements within the airborne test bed. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-03 under a new Air Warfare R-2 Activity) FNC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Design and develop prototype concepts and new processes for a Rocket Propelled Grenade (RPG) hard-kill defense for rotorcraft. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-04 under a new Air Warfare R-2 Activity) - Continue Multi-Spectral EO/IR Seeker Defeat - Refine, test and finalize Infra-Red Countermeasures (IRCM) Electro-Optic/Infra-Red (EO/IR) techniques for flares and jammers using simulation and laboratory tests. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-04 under a new Air Warfare R-2 Activity) FNC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Continue implementation and refinement of the autonomy architecture and algorithms for mission planning, waypoint navigation and vehicle health. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-03 under a new Undersea Warfare R-2 Activity) - Continue MUHV Sensors, Navigation and Guidance - Continue development and maturation of multiband and hybrid sonar, inertial navigation, and fiber-optic systems. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-03 under a new Undersea Warfare R-2 Activity) FNC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Complete Extended-Range Targeting (E-RAT) - Design, develop, and improve prototypes and processes that address extended range targeting and fire control. FNC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM) - Continue Reactive Electronic Attack Measures (REAM) - Implement and assess real-time reactive electronic attack algorithms in a representative environment. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-04 under a new Air Warfare R-2 Activity) FNC: STK-FY17-04 ALPO					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete ALPO - Establish the initial feasibility and practicality solution for an advanced signal-processing system. FNC: STK-FY18-01 PRECISION ELECTRONIC ATTACK TECHNOLOGIES (PEAT) - Continue Multi-platform Retrodirective EW - Continue analyzing synchronized Electronic Warfare (EW) effects across multiple platforms and EW systems. (In FY19, this FNC Product will be realigned within this PE to AW-FY18-01 under a new Air Warfare R-2 Activity) - Continue Single Platform Coherent Arrays - Continue analyzing synchronized EW effects across intra-platform EW components. (In FY19, this FNC Product will be realigned within this PE to AW-FY18-01 under a new Air Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	172.511	165.103	156.805	0.000	156.805

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

As discussed in Section A, there are a significant number of FNC technology products within this PE. In all cases, these technology products support the Department of the Navy FNC Program and are managed at the Office of Naval Research. All FNC investments in this PE are subjected to management oversight by 2-star chaired Integrated Product Teams (IPTs) that control the naval pillars of Sea Shield, Sea Strike, Sea Basing, Forcenet, Naval Expeditionary Maneuver Warfare, Enterprise and Platform Enablers, Power and Energy, Capable Manpower, and Force Health Protection. Each EC is aligned to a pillar and each technology product is aligned to an EC. At the lowest level, each technology product is measured against both technical and financial milestones on a monthly basis. Annually, each technology product is reviewed in depth for technical performance and development status by the Chief of Naval Research against goals that have been approved by the Navy's 3-star Technology Oversight Group (TOG). Also annually, each technology product is reviewed by its 2-star chaired pillar IPT for transition planning adequacy and transition commitment level. Products must meet TOG required transition commitment levels for S&T development to continue. Transition issues and required adjustments are reported annually by the Chief of Naval Research to the TOG, which establishes investment priorities for the FNC Program.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602782N *I Mine & Exp Warfare Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	34.583	33.916	32.733	-	32.733	37.919	36.503	30.659	31.272	Continuing	Continuing
0000: *Mine & Exp Warfare Applied Res*	0.000	34.583	33.916	32.733	-	32.733	37.919	36.503	30.659	31.272	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE provides technologies for Naval Mine Countermeasures (MCM), Expeditionary Warfare, U.S. Naval sea mining, Naval Special Warfare (NSW), and Joint Tri-Service Explosive Ordnance Disposal (EOD) as well as continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable applied research at sea. This program is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capability Objectives through the development of technologies to achieve military objectives with minimal casualties and collateral damage. Within the Naval Transformation Roadmap, this investment will achieve one of three "key transformational capabilities" required by "Sea Shield" as well as technically enable the Ship to Objective Maneuver (STOM) key transformational capability within "Sea Strike" by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. These efforts concentrate on the development and transition of technologies for the MCM-related and Urban Asymmetric/Expeditionary Warfare Operations (UAEO)-related Future Naval Capabilities (FNC) Enabling Capabilities (ECs). The Mine and Obstacle Detection/Neutralization efforts include technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting and neutralization/breaching. The Urban Asymmetric Operation effort includes critical warfighting functions such as Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), fires, maneuver, sustainment, etc. The Naval Special Warfare and Explosive Ordnance Disposal technology efforts concentrate on the development of technologies for safe near-shore mine detection, diver mobility and survivability, and ordnance disposal operations.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602782N *I Mine & Exp Warfare Applied Res*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	37.418	33.916	34.482	-	34.482
Current President's Budget	34.583	33.916	32.733	-	32.733
Total Adjustments	-2.835	0.000	-1.749	-	-1.749
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.116	0.000			
• SBIR/STTR Transfer	-0.719	0.000			
• Program Adjustments	0.000	0.000	-1.749	-	-1.749
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602782N / *Mine & Exp Warfare Applied Res*	Project (Number/Name) 0000 / *Mine & Exp Warfare Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Mine & Exp Warfare Applied Res*	0.000	34.583	33.916	32.733	-	32.733	37.919	36.503	30.659	31.272	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on reducing the time involved in conducting MCM operations and increasing safe standoff from minefields. It develops and transitions technologies for MCM-related and UAEO-related Future Naval Capability Enabling Capabilities (FNC ECs). The MCM effort includes technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting, neutralization/breaching and clearance. The Littoral Warfare effort includes critical warfighting functions such as C4ISR, fires, maneuver, sustainment, etc. The sea mining effort emphasizes technologies for future sea mines. The Naval Special Warfare and Explosive Ordnance technology efforts concentrate on the development of technologies to enhance diver capabilities including: safe near-shore mine sensing, mobility and survivability, and ordnance disposal operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: MINE TECHNOLOGY	0.812	3.835	3.777	0.000	3.777
Description: This activity assesses advanced sea mine technologies to maintain expertise in this Naval Warfare area. An acoustic sensing capability for the naval mine Target Detection Device (TDD) is being addressed. Future mine and minefield concepts are being addressed. The funding increase from FY 2016 to 2017 reflects the realignment of the Advanced Sea Mines Future Naval Capability (FNC) effort SHD-FY16-OSD Modular UnderSea Effectors (MUSE) program from PE 0602750N Future Naval Capabilities Applied Research. ***FY 2016 Accomplishments:*** - Continued analysis of intermediate and deep water minefield concepts. - Continued assessment of sea mine technologies in order to maintain a level of expertise in naval mines. - Continued development of concepts for semi-autonomous and remote controlled mines and minefields. - Continued development of target discrimination technology for Target Detection Device (TDD). ***FY 2017 Plans:*** - Continue all efforts of FY 2016 less those noted as completed above. - Continue the Modular UnderSea Effectors (MUSE) that transferred from PE 0602750N Future Naval Capabilities Applied Research - Develop of acoustic propagation modeling, algorithms for tracking, and algorithms to exploit the acoustic communications environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate investigation into advanced mine sensing concepts. ***FY 2018 Base Plans:*** Conduct applied research in remote control, advanced minefield concepts, minefield planning, and advanced sensors / signal processing. Efforts involved in this area include developments in advanced sensors and algorithmic capabilities that are applicable toward existing target detection devices (TDDs), analysis of intermediate and deep water minefield concepts, development of concepts for semi-autonomous and remote controlled mines and minefields, and assessment of sea mine technologies in order to maintain a level of expertise in naval mines. ***FY 2018 OCO Plans:*** N/A					
Title: MINE/OBSTACLE DETECTION ***Description:*** This activity focuses on applied research to enable longer detection ranges and precise mine location with fewer false alarms in a variety of challenging environments. It supports Discovery and Invention (D&I) and MCM-related FNC ECs. Efforts in Synthetic Aperture Sonar (SAS) technologies for longer range detection and classification of mine-like targets and magnetic gradiometer sensing and electro-optic (EO) technology for buried mine identification, and sensor integration onto Autonomous Underwater Vehicles (AUVs) are being addressed. EO sensor research develops algorithms to enable image processing for rapid overt reconnaissance from an Unmanned Aerial Vehicle (UAV). Other processing, classification and data fusion techniques to reduce operator workload, and a mine burial prediction "expert system" are also being developed. Efforts also support development of MCM Mission Modules for Littoral Combat Ships (LCS). Funding decrease from FY 2016 to FY 2017 is due to the completion of the Airborne Laser Mine Detection Systems (ALMDS) Improvement effort that was part of the Speed to Fleet Initiatives that was a 2 year effort that started in FY 2015. ***FY 2016 Accomplishments:*** - Continued effort to double underwater optical imaging range via the use of time-reversed Light Detection and Ranging (LIDAR) pulse propagation. - Continued development of UUV-based, extended range, electro-optic identification sensors and supporting meteorology and oceanography and planning systems.	23.152	18.858	17.754	0.000	17.754

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued integration of iPUMA and SAS systems in a single vehicle to obtain 100% area coverage. - Continued development of a small ultrasound acoustic underwater camera for UUV-based classification and identification of underwater mines. - Continued development of heat engine for unmanned underwater vehicles powered by thermal gradients in the water column. - Continued development of iPUMA/Synthetic Aperture Sonar system to provide the first non marine mammal based mine detection and classification capability for confined or highly obstructed areas. - Continued development of Small Acoustic Color/Imaging Sonar system to provide the first non marine mammal detection, classification and identification capability for very shallow water (VSW) and reduce the false-alarm rate by x20 for all VSW mine threats. - Completed development of new artificial intelligence technology/techniques required for long duration AUV's. - Completed effort to develop a three-dimensional underwater metamaterial cloaking technology. - Completed effort to provide Navy magnetic silencing ranges with an advanced diagnostic capability to optimize signature reduction techniques. - Initiated applied research into sensor-generic architectures for multi-session minefield mapping with multiple UUVs - Initiated investigation into acoustic radiation forces, or vibro-acoustography to generate new target discrimination feature sets - Initiated applied research in continuous sensing modalities to differentiate between targets and background - Initiated investigation into audition based object formation and attention models for MCM - Initiated applied research in model-based MCM sonar performance estimation - Initiated studies of coastal and riverine environmental characterization to enhance signature reduction for NSW platforms. - Initiated applied research in underwater communications for multiple cooperating minehunting unmanned vehicles. - Completed S2F technology development and demonstration for ALMDS P3I					
FY 2017 Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2016 less those noted as completed above. - Continue effort to double underwater optical imaging range via the use of time-reversed LIDAR pulse propagation. - Complete development of UUV-based, extended range, electro-optic identification sensors and supporting meteorology and oceanography and planning systems. - Complete integration of iPUMA and SAS systems in a single vehicle to obtain 100% area coverage. - Complete development of a small ultrasound acoustic underwater camera for UUV-based classification and identification of underwater mines. - Complete development of heat engine for unmanned underwater vehicles powered by thermal gradients in the water column. -Complete development of iPUMA/Synthetic Aperture Sonar system to provide the first non marine mammal based mine detection and classification capability for confined or highly obstructed areas. - Complete development of Small Acoustic Color/Imaging Sonar system to provide the first non marine mammal detection, classification and identification capability for very shallow water (VSW) and reduce the false-alarm rate by x20 for all VSW mine threats. - Initiate applied research that links observable impacts on acoustic scattering and/or propagation with the underlying phenomenology and/or processes that affect the environment. - Initiate applied research to investigate use of topological spaces for target/clutter features in sonar data. ***FY 2018 Base Plans:*** Conduct Undersea Warfare applied research that investigates and creates new solutions to enable naval forces to conduct more rapid and effective mine detection and classification of moored, proud, and buried mines in high reverberation and man-made clutter environments. The capability to provide effective mine hunting and mine counter-measures from deep water through the beach requires innovative sensor technology, innovative processing techniques, and knowledge and exploitation of the complex operational environments. The advancement of using autonomous underwater vehicles requires investments in underwater acoustic communications, navigation techniques, improved energy densities, hydrodynamics, and vehicle control technologies. Conduct applied research in synthetic aperture sonar (SAS) technologies for longer range detection and classification of mine-like targets, magnetic gradiometer sensing, electro-optic (EO) technology for surface / near-surface mines, buried mine hunting technologies, and sensor integration onto Autonomous Underwater Vehicles (AUVs). Efforts involved in this area include investigations in advanced processing, classification, and					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
data fusion techniques to reduce operator workload; development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars; development of drifting mine detection concepts; high source level, single crystal based projector technologies; thermal engine for unmanned underwater vehicles powered by thermal gradients; modeling of data fusion and mine contact handling; and extension of electro-optical imaging resolution in underwater environments. Complete effort to double underwater optical imaging range via the use of time-reversed LIDAR pulse propagation. ***FY 2018 OCO Plans:*** N/A					
Title: MINE/OBSTACLE NEUTRALIZATION	0.380	0.430	0.428	0.000	0.428
Description: Activity includes applied research to support selected MCM related FNC ECs for rapid mine and obstacle neutralization and sea mine jamming techniques to increase surface ship safe standoff from threat mines. It includes various lethality, vulnerability and dispensing computational tools, models and assessments to support the various far-term Surf Zone (SZ) and Beach Zone (BZ) mine and obstacle breaching concepts. ***FY 2016 Accomplishments:*** - Continued development of system concepts for autonomous neutralization of surface and submerged drifting mines - Continued investigation of techniques for neutralization of buried mines. - Continued investigation of techniques for emulation sweep. - Initiated investigation of technigues for neutralization of moored and drifting ocean mines. ***FY 2017 Plans:*** - Continue all efforts of FY 2016 less those noted as completed above. - Continue investigation of techniques for emulation sweep. - Initiate investigation into coupling of reacquire & identify capabilities with precision neutralization for buried mines. ***FY 2018 Base Plans:*** Conduct applied research in rapid mine and obstacle neutralization and mine sweeping techniques to increase surface ship safe standoff from threat mines. Efforts involved in this area include various lethality, vulnerability, and dispensing models, assessments, and algorithmic approaches to support surf zone (SZ) and beach zone mine and obstacle breaching concepts; techniques for neutralization of buried mines; techniques for emulation					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
sweep; and investigating the coupling of reacquire & identify capabilities with precision neutralization for buried mines. ***FY 2018 OCO Plans:*** N/A					
Title: SPECIAL WARFARE/EOD ***Description:*** The goal of this effort is to develop technologies to extend stand-off of special operations and EOD forces in clandestine hydrography, mine clearance and port security missions while increasing the range and effectiveness of divers. Advanced technologies are needed to gain access to areas contaminated by area-denial sensors and/or booby traps. Developed technologies will transition to the Joint Service EOD Program, the Naval EOD Program, or the DOD Technical Response Group. This activity includes applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems to increase detection range and accuracy in harsh environments. Other efforts include mission support technology improvements for AUVs and human divers - such as communications, navigation and life support. ***FY 2016 Accomplishments:*** - Continued development of technologies to neatralize energetic materials from a safe standoff using small EOD robots. - Continued development of technologies to excavate buried IEDs from a small EOD robot. - Continued development of technologies to demonstrate an autonomous dual manipulator robot for complex underwater EOD missions. - Continued development of technologies to enhance diver situational awareness. - Continued development of technologies to reduce platform vulnerability. - Continued investigation of multi-modal signature reduction technologies for wet/dry-submersibles and semi-submersibles. - Continued development of AUV technologies for autonomous inspection of ship hulls. - Continued development of technologies for contaminated water diving. - Continued development of technologies for enhanced navigation and Intelligence, Surveillance and Reconnaissance (ISR) in riverine environments. - Continued development of technologies to detect and locate IEDs. - Continued development of technologies to access IEDs. - Continued development of technologies to diagnose and identify underwater munitions.	10.239	10.793	10.774	0.000	10.774

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of technologies to identify and diagnose components and characteristics of Improvised Explosive Devices. - Continued development of technologies to detect and locate buried munitions. - Continued effort to support Joint Service Explosive Ordnance Disposal (JSEOD) applied research. - Complete development of an air-delivery method of small/tactical UUVs to extend sensor operational range and expedite ingress. - Complete development of technologies to detect trace and bulk explosive materials from a safe position manually. - Complete development of technologies for prospective tele-autonomy features in EOD robotic platforms command and control. - Initiate development of technologies to diagnose buried ordnance in situ from a safe standoff position manually or using small EOD robots. - Completed development of technologies to dispose of ordnance with insensitive munitions from a safe standoff position manually or using small EOD robots. - Initiated development of technologies for ultra light weight, low cost, highly capable autonomous robotic systems for complex dismounted operations. - Initiated applied research into for autonomous ISR and mapping in canopied coastal and riverine environments - Initiated 'through the sensor' in-stride mapping of coastal and riverine land and seascapes using operational EO/IR, radar and acoustic sensors - Initiated investigation of techniques to detect deeply buried explosive threats and ordnance from a safe standoff distance - Initiated investigation of techniques to neutralize or render safe explosive threats that result in low collateral damage to surrounding infrastructure.					
FY 2017 Plans: - Continue all efforts of FY 2016 less those noted as completed above. - Initiate development of technologies to diagnose buried explosive threats using an EOD robotic platform or a hand-held device. - Initiate development of technologies to detect/locate biological WMD using an EOD robotic platform or a hand-held device.					
FY 2018 Base Plans: Conduct applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems, mission support technology improvements for AUVs and human divers (e.g., communications, navigation, and					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
life support), and threat identification, exploitation, and remediation technologies. Efforts involved in this area include development of technologies to excavate buried IEDs, dual manipulator robots for complex underwater EOD missions, technologies to enhance diver situational awareness and autonomous inspection of ship hulls, support of Joint Service Explosive Ordnance Disposal (JSEOD) applied research, and detection of trace and bulk explosive materials. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	34.583	33.916	32.733	0.000	32.733

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of this applied research program are the development of technologies which focus on the Expeditionary Warfare challenge of speeding the tactical timeline and increasing safe standoff from minefields. Individual project metrics include the transition of 6.2 technology solutions into 6.3 advanced technology programs.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602792N *I (U)Innovative Naval Prototypes(INP) Applied Res*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	0.000	171.146	-	171.146	160.349	161.929	161.945	165.184	Continuing	Continuing
0000: *(U)Innovative Naval Prototypes(INP) Applied Res*	0.000	0.000	0.000	171.146	-	171.146	160.349	161.929	161.945	165.184	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Innovative Naval Prototypes (INP) Program and its associated Leap Ahead Technology (LA-Tech) investments. These investments represent game-changing technologies with the potential to revolutionize operational concepts. They are disruptive in nature as they would dramatically change the way naval forces fight. INPs push the imagination of our nation's technical talent to deliver transformational warfighting capabilities. The projects in this portfolio are high risk, technically challenging technology development efforts that offer the potential of high warfighting payoff in the future. The goal of these investments is to develop and demonstrate the viability of new technological capabilities via experimental prototypes that prove the new capability could be implemented if an acquisition program were to be established to further develop the demonstrated capability. These investments are selected by a process that involves senior leadership in the Department of the Navy, with new INPs approved by the 4-star RDT&E Corporate Board.

Developing INPs and Leap Ahead Technologies requires a systematic expansion and application of knowledge to develop useful materials, devices, and systems oriented toward the design and development of prototypes applicable to specific mission area requirements. The efforts funded within this PE translate promising basic research into solutions for broadly defined military needs. These efforts include developing breadboard hardware and algorithms that establish the initial feasibility and practicality of proposed solutions to technological challenges, as well as other pre-Milestone B efforts such as concept exploration efforts, studies, investigations, and non-system specific technology efforts.

This is a new PE for FY 2018 that consolidates all Navy 6.2 Applied Research investments funding INPs and their associated LA-Tech investments into a single Navy 6.2 PE. In FY 2017, these investments were spread across 4 separate 6.2 PEs: 0602114N Power Projection Applied Research , 0602123N Force Protection Applied Research, 0602271N Electromagnetic Systems Applied Research, and 0602747N Undersea Warfare Applied Research. The consolidation in this PE allows all investments within this portfolio to be viewed in one place. It greatly enhances the visibility of the Program by providing an easily navigable overview of all 6.2 INP and LA-Tech investments in a single place.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602792N *I (U)Innovative Naval Prototypes(INP) Applied Res*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	171.146	-	171.146
Total Adjustments	0.000	0.000	171.146	-	171.146
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	171.146	-	171.146

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	Project (Number/Name) 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *(U)Innovative Naval Prototypes(INP) Applied Res*	0.000	0.000	0.000	171.146	-	171.146	160.349	161.929	161.945	165.184	Continuing	Continuing

A. Mission Description and Budget Item Justification

Innovative Naval Prototype (INP) investments are typically 4-8 years in duration. They provide a continuance of basic research by maturing technologies from a Technology Readiness Level (TRL) of 2 or 3 to a TRL of 6. All prototypes developed within this program require BA2 and BA3 funded technology development, which is coordinated to ensure the investments conclude with a demonstration proving the feasibility of the new technological capability in relevant environment. The portfolio is periodically refreshed through the selection of new INPs and Leap Ahead Technology (LA-Tech) investments as existing ones are completed. Successful demonstrations are intended to present the Department of the Navy with a programmatic challenge as these new capabilities can lead to the obsolescence of existing capabilities, requiring significant decisions as to the path forward for integrating the new technological capabilities into the warfighting systems of the future.

INPs and LA-Tech investments, including FY17 jump start efforts, have been collectively grouped into R-2 Activities that include Unmanned and Autonomous Systems, Directed Energy / Electric Weapons, Electromagnetic Maneuver Warfare, Cyber and Undersea Warfare.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Cyber	0.000	0.000	24.923	0.000	24.923
Description: This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for cyber warfare. FY 2018 reflects the sum total of all BA 6.2 efforts in the program. Applied research for the Total Platform Cyber Protection (TPCP) INP shown below was initiated in FY17 under PE 0602123N Force Protection Applied Research. The INP was selected after the President's Budget for FY17 was delivered to the Congress. Starting in FY 2018, all INP/LA-Tech investments in Cyber warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area.					
FY 2016 Accomplishments: N/A					
FY 2017 Plans: N/A					
FY 2018 Base Plans: INP: Total Platform Cyber Protection (TPCP)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue the TPCP project, previously funded in PE 0602123N Force Protection Applied Research. Develop leap-ahead resilient cybersecurity tools that will enable our warfighting platforms to fight through current and future unauthorized cyber intrusions and assure command and control of any naval platform (submarine, surface, and air platforms) providing an adaptive cyber toolkit and real time cyber sensors. This project develops cyber sensors and automated vulnerability assessment cyber tools that deliver comprehensive defense-in-depth cyber capabilities to monitor, detect, mitigate, and recover from cyber threats in near real-time. This project will develop software based capabilities and a compact and affordable computing appliance applicable to any aircraft, surface vessel, submarine or ground vehicle. The technical development will leverage dynamic and active sensing and cyber vulnerability prevention science and technology approaches, including formal methods, model checking, and static/dynamic analyses which reduce cyber platform attack surfaces, prevent the exploitation of system vulnerabilities, shorten detection timelines, and perform other mitigation functions. Commercial off-the-shelf software components will be leveraged to develop technology for de-bloating and delayering so as to reduce the attack surface and ensure platform resiliency against unauthorized cyber intrusions. ***FY 2018 OCO Plans:*** N/A					
Title: Directed Energy / Electric Weapons ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for directed energy and electric weapons. FY 2018 reflects the sum total of all such BA 6.2 efforts in the program. Continued and completing applied research efforts in this R-2 Activity were previously funded in PE 0602114N Power Projection Applied Research. Starting in FY 2018, all INP and LA-Tech investments in directed energy and electric weapons will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Electro-Magnetic Railgun (EMRG)	0.000	0.000	57.475	0.000	57.475

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue EMRG, previously funded in PE 0602114N Power Projection Applied Research. The EMRG capability will support Naval Surface Fire Support (NSFS), Integrated Air and Missile Defense (IAMD), Fast Attack Craft and Fast Inshore Attack Craft (FAC/FIAC) and Anti-Surface Warfare (ASuW) missions. Conduct applied research addressing the unique technical challenges inherent in the construction, assembly and operation of an Electro Magnetic (EM) railgun prototype capable of launching long range projectiles repeatedly, many times per minute. Special materials and compact sub-system components will be developed that are capable of operating in harsh thermal and electromagnetic environments. Advanced modeling tools will be developed to assess design options, analyze system concepts and inform experimental hardware design and testing. Develop and test next generation battery energy storage and pulsed power components to assess performance and applicability towards future designs. Develop and refine algorithms for controlling the precision timed electromagnetic pulse used to fire the railgun in the rep-rate mode. Conduct material, physics and thermal property research for long-life, rep-rate electromagnetic launch systems and actively monitor performance to understand the high currents, elevated operating temperatures, and cooling of components, so as to improve designs and increase their reliability. Develop modeling and simulation tools that support electromagnetic launch, multi-shot life development, testing, and assessments. LA-Tech: Solid State Laser Technology Maturation (SSL TM) Complete the SSL TM project, which was previously funded in PE 0602114N Power Projection Applied Research. Finish development of technologies suitable for a solid state laser weapon system, including technologies for a maritime beam director, targeting, tracking and laser subsystems, which are capable of supporting future Navy surface ship defensive missions to defeat small boat and Unmanned Aerial Vehicle (UAV) swarms, and which provide Intelligence, Surveillance and Reconnaissance (ISR) disruption and/or defeat. This effort includes conducting scientific studies that address the modeling and simulation critical to understanding the missions involved in a layered defensive capability in the maritime environment. Conclude testing against threat representative targets, components and subsystems to determine weapon capabilities and lethality. These tests provide data that support improved modeling and simulation and the development of governing technical requirements for an integrated High Energy Laser (HEL) weapon system capable of conducting Navy surface ship self-defense missions. Finish studies of atmospheric scattering, absorption and turbulence effects in low altitude, maritime, surface conditions, which provide critical data for understanding the impact of boundary layer and sea-water-air turbulent mechanics on future laser weapon systems effectiveness. Complete scientific studies and testing on laser subcomponents, including tests on laser pump diodes and laser					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
gain media. These laser subcomponent technologies have potential in future weapon acquisition programs that are based on solid state laser technologies. Efforts in this area will focus on emerging commercial technologies and government sponsored research that is suitable for use in the maritime domain. Conclude scientific trade studies of notional predictive avoidance systems, which examine the control interfaces between sensors and future prototypical naval laser weapons and provide an inherent 'safe-arm' function for the projection of laser power at long range (potentially beyond visible, line-of-sight distances). The capability to halt laser energy propagation in real time while performing Navy surface ship self-defense missions is necessary to avoid inadvertent illumination of non-threat forces (e.g., friendly sensors or platforms). Conduct testing of the laser weapon system demonstrator, including a Tactical Laser Core Module (TLCM). LA-Tech: High-power Joint Electromagnetic Non-Kinetic Strike (HIJENKS) Continue HIJENKS, a joint USAF/USN project previously funded as a FY17 Leap-Ahead jump-start effort in PE 0602114N Power Projection Applied Research. Develop a High Power Radio Frequency (HPRF) technology payload integrated on an air platform capable of engaging multiple electronic targets with a single, scalable effects weapon across a variety of warfighting missions. This effort will culminate in a live-fire demonstration of a multi-mission/multi-target HPRF payload integrated into a demonstration platform. The operational impacts include decreased cost exchange ratios, non-kinetic counter electronic effects, reduced collateral damage, and the ability to engage multiple targets with a single weapon. This effort aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. During FY18, the following applied research development efforts are planned: investigate Radio Frequency (RF) effects on complex electronic systems with the goal being to finalize an RF waveform specification; investigate HPRF weapons effects for non-kinetic counter electronics to include the prediction model improvements required for mission planning of Directed Energy Weapons (DEW); perform Modeling and Simulation (M&S) to capture RF antenna output, RF propagation, RF interaction with complex enclosures, and RF interaction with electronic circuits to characterize DEW performance to the maximum extent possible; conduct research into the time-out of action or recuperation time for complex electronics, exploring Battle Damage Indicators (BDI) for electronic disruption; determine the critical pulsed power and RF components required to reduce the HPRF payload's Size, Weight, and Power (SWaP); perform a trade-off analysis of the technology alternatives, their maturity, and their suitability for this application; develop the most promising component technologies, such as conformal antenna designs for high power, advanced high power RF source technologies, pulsed power components with higher energy densities, and advanced architectures and magnetic materials for high voltage power electronics systems; conduct risk reduction research for the RF source and					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
antenna subsystems by examining high risk, high payoff technology alternatives to improve output power while simultaneously reducing system size and weight, and examine the efficiency of each subsystem and the impact of overall payload prime power requirements. ***FY 2018 OCO Plans:*** N/A					
Title: Electromagnetic Maneuver Warfare ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Electromagnetic Maneuver Warfare (EMW). FY 2018 reflects the sum total of all such BA 6.2 efforts in the program. These efforts were previously funded in PE 0602271N Electromagnetic Systems Applied Research. Starting in FY 2018, all INP and LA-Tech investments in Electromagnetic Maneuver Warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** INP: Electromagnetic Maneuver & Control Capability (EMC2) Continue the EMC2 project by conducting applied research efforts that will enable a battle group to work cooperatively in the Electromagnetic Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), Communications and Radar performance. EMC2 will develop technology that optimizes Radio Frequency (RF) resources in order to meet the commander's intent across multiple warfare areas simultaneously within a single platform and across a strike group. It will complete technology development and design that will be used for a Low-band RF Intelligent Distribution Resource (LowRIDR) prototype. In addition, EMC2 will conduct studies and continue the technology development and design for a wideband, multifunction airborne system that will be integrated with ship-based, wideband multifunction systems.	0.000	0.000	24.086	0.000	24.086

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
INP: Nemesis Complete the Nemesis project by finishing research efforts to develop and mature technologies in multiple areas that will be used to assess the feasibility of Nemesis to coordinate Electronic Warfare (EW) operations across distributed EW systems. Technologies being matured include swarming vehicle operations, distributed resource mission control, multi-domain coordinated operations and advanced RF component and subsystems technologies. These emerging technologies are being designed and developed for prototype Nemesis systems which will be capable of performing coordinated EW operations across distributed EW systems.					
Title: INP Management ***Description:*** This R-2 Activity includes the Science and Technology (S&T) analyses and studies required to take new Innovative Naval Prototypes (INPs) and Leap Ahead Technology (LA-Tech) investments and produce the detailed technology specifications and performance metrics needed to procure the component level technologies that must be developed and tested in order to build the intended prototypes. This activity includes development and implementation of innovative and dynamically changing technology management business processes required to manage the INP and LA-Tech investment portfolio. These efforts were previously funded in PEs 0602114N Power Projection Applied Research, 0602123N Force Protection Applied Research, 0602271N Electromagnetic Systems Applied Research, and 0602747N Undersea Warfare Applied Research. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP Management Continue INP Management Support/OPS Analysis (previously funded in PEs 0602114N Power Projection Applied Research, 0602123N Force Protection Applied Research, 0602271N Electromagnetic Systems Applied Research, and 0602747N Undersea Warfare Applied Research. Conduct applied research and analysis, including technology management of Innovative Naval Prototypes (INPs) and Leap Ahead Technology (LA-	0.000	0.000	1.500	0.000	1.500

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Tech) investments supporting Department of the Navy priorities for emerging technologies of a disruptive and game changing nature. ***FY 2018 OCO Plans:*** N/A					
Title: Undersea Warfare ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Undersea Maneuver Warfare (UMW). FY 2018 reflects the sum total of all such BA 6.2 efforts in the program. These efforts were previously funded in PE 0602747N Undersea Warfare Applied Research. Starting in FY 2018, all INP and LA-Tech investments in Undersea Maneuver Warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Forward Deployed Energy & Communications Outpost (FDECO) Continue the FDECO project, previously funded in PE 0602747N Undersea Warfare Applied Research. Continue the FDECO architecture planning study to analyze distributed, open, adaptable, and scalable architectures suitable to future naval demands. Conduct limited objective experiments of component technologies for docking, energy transfer, communications and control. The docking task will focus on developing and testing technologies and approaches that are vehicle agnostic (type & size), reliable and repeatable. The energy task will focus on developing and testing technologies and approaches that maximize the availability and efficiency to transfer electrical energy to/from various networked energy sources and sinks (FDECO batteries, vehicle batteries, communication systems and sensors). The communications task will focus on developing interface control definitions that support plug-and-play operation, federated network protocols, multiple communication modalities, dynamic latencies, various bandwidths, and adaptive command & control structures.	0.000	0.000	14.732	0.000	14.732

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
LA-Tech: Anti-Submarine Warfare Mission Packages (ASW MP) Continue ASW MP, previously funded in PE 0602747N Undersea Warfare Applied Research. The ASW MP is developing a set of sensors and autonomy algorithms to enable a Large Displacement Unmanned Undersea Vehicle (LDUUV) to perform a classified ASW mission. The 6.2 funds will be used to develop technology components of the mission packages and develop autonomy algorithms. During FY18, design of situational awareness sensor electronics and components will be initiated and algorithms will be developed for mission autonomy and the mission state generator. Fabrication of sensor hardware components will begin and software development will be conducted. ***FY 2018 OCO Plans:*** N/A					
Title: Unmanned and Autonomous Systems	0.000	0.000	48.430	0.000	48.430
Description: This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Unmanned and Autonomous Systems. FY 2018 reflects the sum total of all such BA 6.2 efforts in the program. These efforts were previously funded in PE 0602123N Force Protection Applied Research, 0602271N Electromagnetic Systems Applied Research and 0602747N Undersea Warfare Applied Research. Starting in FY 2018, all INP and LA-Tech investments in Unmanned and Autonomous Systems will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Autonomous Aerial Cargo/Utility System (AACUS) Complete the AACUS project, which was previously funded in 0602123N Force Protection Applied Research. The AACUS project will complete research efforts to develop and mature technologies that perform autonomous take-off, conduct en-route navigation, classify the terrain of landing zones, detect and avoid ground-based obstacles, and safely operate in degraded visual environments. In addition to maturing these individual					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
technologies, specific attention will be directed toward the task of integrating them into a full scale autonomous platform to increase their technology readiness level. INP: Claws Initiate Claws. Claws will develop the autonomy required to operate large and extra-large Unmanned Undersea Vehicles (UUVs) in an anti-access, anti-denial environment. To support large and extra-large UUV operations further forward and farther from the battle group, the technology will be evolved to allow operations with limited navigational fixes and limited communication opportunities. During FY18, research will be conducted and technology will be matured in the areas of precision navigation, obstacle avoidance, robust communications, on-board vulnerability assessment, and payload autonomy. Applied research efforts in advanced undersea autonomy will also be initiated. INP: Large Displacement Unmanned Undersea Vehicle (LDUUV) Complete the LDUUV project, which was previously funded in 0602747N Undersea Warfare Applied Research. The LDUUV INP is developing the critical technologies of energy, autonomy, endurance, and submarine launch and recovery. These critical technologies are needed to enable Large UUVs to be pier and ship launched, and recovered. The technologies will enable the completion of missions with long ranges, as well as those requiring over 60 days of endurance for Intelligence, Surveillance, and Reconnaissance (ISR) tasks. Continue development of the long endurance, air-independent energy source technology for large UUVs. Continue development of the autonomy technology that will support operation of the UUV in the littorals. Continue development of core UUV technologies that will extend the reliability and endurance of the UUV operating in the littorals. Conduct a UUV fuel cell systems technology analysis, which will be used to support a land-based demonstration. INP: Low-Cost UAV Swarming Technology (LOCUST) Continue the LOCUST project, previously funded in PEs 0602114N Power Projection Applied Research and 0602123N Force Protection Applied Research. LOCUST will ultimately deliver a scalable system of inexpensive Unmanned Aerial Vehicles (UAVs) and payloads that will provide game-changing disruptive capabilities over a wide range of military operations and areas of operations. LOCUST will make advances in unmanned system collective autonomous behaviors, robust low probability of interception or detection ad hoc networks, and					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
payload miniaturization and modularity breakthroughs to counter threats in constrained urban environments, as well as large-scale anti-access area denial defenses. This will be accomplished at greatly reduced cost and risk when compared to traditional manned platform target prosecution. The applied research effort in 2018 specifically will conduct preliminary system design and technology developments within the three major LOCUST sub-systems: (1) the Distributed, Collaborative, Coordinated, & Cognitive autonomy system architecture; (2) the distributed Command & Control system architecture; and (3) a series of modular UAV payloads. LA-Tech: Large Displacement UUV - Advanced Power and Energy Demonstration (LDUUV-APED) Continue LDUUV-APED, which was previously funded in PE 0602747N Undersea Warfare Applied Research. The LDUUV-APED Program is integrating the Aluminum Power System (ALPS) air-independent fuel cell system into an existing LDUUV vehicle and conducting at-sea testing to demonstrate a mission endurance capability that meets the Navy's UUV far-term objectives (up to 70 days) for a persistent forward presence. During FY18, the hull structural design and analysis will be completed and the energy section hull will be fabricated. Integration of ALPS into the energy section hull will begin. Modifications to the vehicle to accept the ALPS energy section will begin. The notional mission profiles will be finalized and development of the test plan will begin. The vehicle-level hazards analysis will be completed and the range approval process will continue to be supported. LA-Tech: Medium Displacement Unmanned Surface Vehicle (MDUSV) Continue MDUSV, which was previously funded in 0602123N Force Protection Applied Research. The MDUSV project will continue research efforts to develop and mature technologies in multiple areas that will be used to assess the feasibility of an MDUSV to perform Mine Countermeasures (MCM), Anti-Submarine Warfare (ASW) and Electronic Warfare (EW) mission area requirements. Autonomy technologies being matured include a robust perception approach using Electro-Optic/Infrared (EO/IR) sensors and technologies that enable autonomous all-weather operations, detection of low radar cross section craft, reduced vulnerability to jamming, and operations with reduced Radio Frequency (RF) emissions. MCM technologies being developed include mine sweeping capabilities using High Temperature Superconductor (HTS) magnets in combination with acoustic sweep technologies. ASW technologies being developed include an advanced version of the Non-Traditional Sensor System (NTSS) to be assessed for its autonomous ASW track and trail capability. The project also includes development of an NTSS EW payload integrated with an MS3 Sonar. These emerging					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
technologies are being designed and developed for an MSUSV prototype that will be capable of performing multiple autonomous missions over extended periods of time. LA-Tech: Tern Complete Tern, a joint ONR and DARPA project, previously funded in 0602123N Force Protection Applied Research. Continue airplane launch and recovery component and subsystem technology developments to enable medium size, long-endurance, long-range Unmanned Aerial Vehicles (UAVs) to be launched and recovered on short deck ships. Continue the maturation of technology addressing integration challenges associated with developing a Vertical Take-Off and Landing (VTOL) UAV capability. LA-Tech: USV Swarm Continue USV Swarm, which was previously funded in PE 0602271N Electromagnetic Systems Applied Research . Conduct applied research into cooperative autonomy for unmanned surface vehicle swarms including task allocation, route planning and perception. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	0.000	0.000	171.146	0.000	171.146

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

In all cases, the technologies being developed within this PE support the Department of the Navy INP Program and are managed at the Office of Naval Research. The primary technological metrics used in this PE involve experiments and tests that demonstrate proof of concept for the technological capability being developed. All investments are coordinated with the acquisition, resources/requirements, and Fleet communities, with periodic briefs given to the Department of the Navy's leadership, including the 4-star RDT&E Corporate Board. At the lowest level, each project is measured against technical and financial milestones on a periodic and frequent basis.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602792N / *(U)Innovative Naval Prototypes(INP) Applied Res*	**Project (Number/Name)** 0000 / *(U)Innovative Naval Prototypes(INP) Applied Res*

Annually, each project is reviewed in depth for technical performance and development status by the Chief of Naval Research. Department of the Navy leadership, including the RDT&E Corporate Board is briefed on the program's status at least annually, if not more often, by the Chief of Naval Research.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602861N *I (U)Science & Tech Management - ONR Field Acts*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	0.000	62.722	-	62.722	64.236	65.912	67.093	68.502	Continuing	Continuing
0000: *(U)Science & Tech Management - ONR Field Acts*	0.000	0.000	0.000	62.722	-	62.722	64.236	65.912	67.093	68.502	Continuing	Continuing

Note

N/A

A. Mission Description and Budget Item Justification

This is a newly established Program Element (PE) for the Office of Naval Research (ONR) to cover corporate expenses including salaries, Information Technology (IT), Financial Improvement Plan (FIP) efforts, Defense Finance and Accounting Service (DFAS) Billings, and some of the day-to-day logistical costs. The vast majority of these items represent fixed costs associated with Scientists and Engineers supporting the Navy's Science and Technology (S&T) Programs.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	62.722	-	62.722
Total Adjustments	0.000	0.000	62.722	-	62.722
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	61.943	-	61.943
• Rate/Misc Adjustments	0.000	0.000	0.779	-	0.779

Change Summary Explanation

Effective in FY18 funding was transferred from PE 0605861N RDT&E Science & Technology Management. The transfer consolidates ONR Non-Management Headquarters Activity (Non-MHA) Science & Technology (S&T) Management in 6.2 and improves reporting of Navy's S&T investment by including S&T management as part of the S&T topline.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602861N / *(U)Science & Tech Management - ONR Field Acts*	Project (Number/Name) 0000 / *(U)Science & Tech Management - ONR Field Acts*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *(U)Science & Tech Management - ONR Field Acts*	0.000	0.000	0.000	62.722	-	62.722	64.236	65.912	67.093	68.502	Continuing	Continuing

Note

N/A

A. Mission Description and Budget Item Justification

This project supports ONR leadership, management and direction for the Naval S&T program. This project funds ONR HQ Non-Management Headquarters Activities (Non-MHA) salaries, communications, and other fixed costs. ONR sponsors scientific advances, which lead to Future Naval Capabilities (FNCs), supporting the Fleet's ability to operate from a position of technological superiority. Functions performed include (1) scientific and technical direction of the nationwide 6.1 basic research program with colleges, universities, non-profit organizations and Naval Laboratories and Warfare Centers; (2) scientific and technical direction of the 6.2 applied research program through the Naval R&D laboratories and Warfare Centers and industry; (3) scientific and technical direction of the Naval 6.3 advanced technology development program through the Navy's R&D laboratories, Warfare Centers and industry; (4) management, resource formulation, program assessment, and contract negotiation/administration of the Navy basic research, applied research and advanced technology development program; and (5) coordination of the Navy's Technology Base program within the context of total DoD/Government (e.g., National Science Foundation, National Academy of Sciences) R&D initiatives in order to maximize scientific advances. This project also supports ONR Non-MHA management and direction for the following Navy-wide programs: Small Business Innovation Research, Naval Research Advisory Committee, Navy Patent Program, Historically Black Colleges and Universities/Minority Institutions Program, Navy Manufacturing Technology Program and the Ballistic Missile Submarine Nuclear (SSBN) Security Technology Program.

Additionally, this project funds ONR field salaries, communications, and other fixed costs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: (U) Science & Tech Management - ONR Field Acts	0.000	0.000	62.722	0.000	62.722
Description: This project provides for Non-MHA costs of ONR Headquarters in support of the entire Navy S&T program. Most all the funds in this project are fixed costs, such as salaries and communications. Specifically, it pays the salaries of Scientific and Engineering and corporate business personnel who direct the execution of the Navy's basic research, applied research, and advanced technology development programs at the nation's universities/colleges, Navy laboratories, Warfare Centers, and private industry. This is a newly established Program Element (PE) in FY18 for the Office of Naval Research (ONR) to cover Non-MHA costs. Funds were transferred from PE 0605861N RDT&E Science and Technology Management.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602861N / *(U)Science & Tech Management - ONR Field Acts*	**Project (Number/Name)** 0000 / *(U)Science & Tech Management - ONR Field Acts*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FY 2016 Accomplishments: N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** This project provides for all costs of ONR Headquarters in support of the entire Navy S&T program. Most all of the funds in this project are fixed costs, such as salaries, and communications. Specifically, it pays the salaries of Scientific and Engineering and corporate business personnel who direct the execution of the Navy's basic research, applied research, and advanced technology development programs at the nation's universities/ colleges, Navy laboratories, Warfare Centers, and private industry. This project provides for all basic costs of ONR activities in support of the entire Navy S&T program. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	0.000	0.000	62.722	0.000	62.722

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE funds operating costs for ONR's mission. Program performance is measured by attaining financial benchmarks for planned obligations vs. actual obligations and planned expenditures vs. actual expenditures.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602898N *I (U)Science & Tech Management - ONR Headquarters*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	29.575	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.575
0000: *(U)Science & Tech Management - ONR Headquarters*	0.000	0.000	29.575	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.575

A. Mission Description and Budget Item Justification

This is a newly established Program Element (PE) for the Office of Naval Research (ONR) to centrally fund Management Headquarters Activity (MHA) corporate support for the Navy Science and Technology program. Funding includes logistics, acquisition, and communications support for the Command.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	0.000	29.575	28.363	-	28.363
Current President's Budget	0.000	29.575	0.000	-	0.000
Total Adjustments	0.000	0.000	-28.363	-	-28.363
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	-28.363	-	-28.363

Change Summary Explanation

The FY 2017 funding increase was the realignment of funds from the Science Programs into this newly established PE.

The decrease in funding from FY 2017 to FY 2018 reflects the transfer of ONR non-labor MHA support for the Navy S&T programs to PE 0605898N Management HQ - R&D.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602898N / *(U)Science & Tech Management - ONR Headquarters*	Project (Number/Name) 0000 / *(U)Science & Tech Management - ONR Headquarters*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *(U)Science & Tech Management - ONR Headquarters*	0.000	0.000	29.575	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.575

Note

N/A

A. Mission Description and Budget Item Justification

This is a newly established Program Element (PE) for the Office of Naval Research (ONR) to centrally fund Management Headquarters Activity (MHA) corporate support for the Navy Science and Technology program. Funding includes logistics, acquisition, and communications support for the Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: (U) Science & Tech Management - ONR Headquarters	0.000	29.575	0.000	0.000	0.000
Description: This project funds all basic non-labor costs of Office of Naval Research Management Headquarters Activity (MHA) in support of the entire Navy S&T program. The FY 2017 funding was realigned from the Science Programs into this newly established PE. The decrease in funding from FY 2017 to FY 2018 reflects the transfer of ONR Non-Labor MHA support for the Navy S&T programs to PE 0605898N Management HQ - R&D. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** This project provides for ONR non-labor MHA support for the Navy S&T programs. Specifically, funding facilitates the execution of the Navy's basic research, applied research, and advanced technology development programs at the nation's universities/colleges, Navy laboratories, Warfare Centers, and private industry. Provide corporate support in facilitating the purchase of the S&T programs for the Navy. ***FY 2018 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602898N / *(U)Science & Tech Management - ONR Headquarters*	**Project (Number/Name)** 0000 / *(U)Science & Tech Management - ONR Headquarters*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Funds transferred to 0605898N Management HQ - R&D					
FY 2018 OCO Plans: N/A					
Accomplishments/Planned Programs Subtotals	0.000	29.575	0.000	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE funds ONR management headquarters non-labor costs. Program performance is measured by attaining financial benchmarks for planned obligations vs. actual obligations and planned expenditures vs. actual expenditures.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603114N *I Power Projection Advanced Technology*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	41.957	96.406	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	138.363
2911: *Power Proj Adv Tech*	0.000	41.957	96.406	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	138.363

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science & Technology Strategic Plan approved by the S&T Corporate Board as of 20 January 2015. This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

The programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	36.971	96.406	12.392	-	12.392
Current President's Budget	41.957	96.406	0.000	-	0.000
Total Adjustments	4.986	0.000	-12.392	-	-12.392
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	5.410	0.000			
• SBIR/STTR Transfer	-0.424	0.000			
• Program Adjustments	0.000	0.000	-12.392	-	-12.392

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the remaining Precision Strike Technology efforts to PE 0603758N Navy Warfighting Experimentation and Demonstration. Additionally, Innovative Naval Prototypes (INPs) Electromagnetic Railgun (EMRG) and Solid State Laser (SSL) program work will continue in the new INP PE 0603801N Innovative Naval Prototypes.

Technical: Not applicable.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603114N *I Power Projection Advanced Technology*

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603114N / *Power Projection Advanced Technology*	Project (Number/Name) 2911 / *Power Proj Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2911: *Power Proj Adv Tech*	0.000	41.957	96.406	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	138.363

A. Mission Description and Budget Item Justification

This project supports the Time Critical Strike (TCS) and ForceNet FNC components which address technological issues associated with the development of strike weapons that significantly decrease the launch to engagement timeline; provide the Navy of the future the ability to quickly locate, target, and strike critical targets; and enhance mission capabilities and operational utility of Naval forces by dramatically increasing the autonomy, performance, and affordability of Naval organic, Unmanned Vehicle systems. The Navy is furthering the development of solid state, high energy laser technology for use as a weapon system on future surface ships.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: PRECISION STRIKE TECHNOLOGY	41.957	96.406	0.000	0.000	0.000
Description: Efforts in this area support Naval Precision Strike Operations, providing the Navy capability to quickly locate, target, and strike critical targets. FY 2016 to FY 2017 increase in funding is due to Solid State Laser Technology Maturation Program (SSL-TM) program entering its fabrication and testing phase. The funding decrease from FY 2017 to FY 2018 reflects the realignment of the remaining Precision Strike Technology efforts to PE 0603758N Navy Warfighting Experimentation and Demonstration. Additionally, Innovative Naval Prototypes (INPs) Electromagnetic Railgun (EMRG) and Solid State Laser (SSL) program work will continue in the new INP PE 0603801N Innovative Naval Prototypes. ***FY 2016 Accomplishments:*** - Continued kill-chain studies to identify and recommend engineering trades to enable weapon system interoperability and data fusion alternatives. These studies assess engineering feasibility of various kill-chain options and assess the capability provided. Continue EMRG. The EMRG capability will support Naval Surface Fire Support (NSFS), Integrated Air and Missile Defense (IAMD), Fast Attack Craft and Fast Inshore Attack Craft (FAC/FIAC) and Anti-Surface Warfare (ASuW) missions. Design, fabricate and integrate Electro Magnetic (EM) railgun subsystems and components into a system prototype capable of rep-rate operations. Assess the manufacturability of major components such as the railgun launcher and pulsed power modules, which are key to the technology capability. Conduct preliminary prototype system tests and demonstrations to prove the technological feasibility of the EMRG					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603114N / *Power Projection Advanced Technology*	**Project (Number/Name)** 2911 / *Power Proj Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
capability and assess sub-system and component operability under stressing rep-rate conditions. Continue developing and testing a prototype rep-rate railgun launcher that is suitable for installation in a prototype railgun gun mount, where the design of the power and energy architecture necessary to support the prototype EMRG system can be assessed. Continue to test and build full-scale electro-magnetic railgun system prototypes that include the battery charging system, the pulsed power subsystem, and the electromagnetic launcher. Perform full-scale testing of long-life railgun launcher material solutions inserted in laboratory launchers. Design, build, test, and evaluate iterative electromagnetic railgun composite launcher prototypes to demonstrate the technological feasibility, performance, multi-shot life, and suitable firing rate of the system. Continue activities to integrate and test a Hyper Velocity Projectile (HVP) for use with the EMRG. Continue SSL TM. Continue development of a maritime laser weapons system prototype and test it on a representative test platform for a naval surface combatant. Conduct the required laser weapon system engineering, design, integration and testing necessary to have a testable, experimental prototype. This system will be capable of supporting missions such as defense against small boat and Unmanned Aerial Vehicle (UAV) swarms and Intelligence, Surveillance and Reconnaissance (ISR) disruption and defeat. The results of scientific and engineering trade studies, including those that measure atmospheric absorption and turbulence, will be used to support the integration and testing of a maritime beam director and a high power, Solid State Laser (SSL) capable of tracking and engaging surface and airborne targets at a relevant stand-off distance in the maritime environment. A Hybrid Predictive Avoidance Safety System (HPASS) will be integrated with a solid state laser weapon system demonstrator to de-conflict laser operations with friendly sensors and platforms. At-sea testing will be conducted on the full laser weapon system demonstrator (i.e., prototype) from a representative test platform for a naval surface combatant. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	41.957	96.406	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603114N / *Power Projection Advanced Technology*	**Project (Number/Name)** 2911 / *Power Proj Adv Tech*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The metrics used are programmatic milestones and technical milestones, such as completion of technical trade studies examining suitable technologies for subsequent prototype development; incremental laboratory and field testing of components and sub-systems; and delivery of industry-developed prototypes for demonstration.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603123N *I Force Protection Advanced Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	42.333	48.438	26.342	-	26.342	37.032	35.769	24.769	22.058	Continuing	Continuing
2912: *Force Protection Advanced Technology*	0.000	39.767	45.713	23.568	-	23.568	34.258	32.995	21.995	19.275	Continuing	Continuing
3049: *Force Protection*	0.000	2.566	2.725	2.774	-	2.774	2.774	2.774	2.774	2.783	Continuing	Continuing

Note

There are two new Leap Ahead initiatives starting in FY 2016 - Forward Deployed Energy & Communications Outpost (FDECO) Innovative Naval Prototype (INP) and Medium Displacement Unmanned Surface Vehicle (MDUSV) effort.

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE addresses advanced technology development associated with providing the capability of Platform and Force Protection for the U.S. Navy. This program supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603123N *I Force Protection Advanced Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	38.044	48.438	49.554	-	49.554
Current President's Budget	42.333	48.438	26.342	-	26.342
Total Adjustments	4.289	0.000	-23.212	-	-23.212
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	5.202	0.000			
• SBIR/STTR Transfer	-0.913	0.000			
• Program Adjustments	0.000	0.000	-23.212	-	-23.212

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603123N / *Force Protection Advanced Technology*	Project (Number/Name) 2912 / *Force Protection Advanced Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2912: *Force Protection Advanced Technology*	0.000	39.767	45.713	23.568	-	23.568	34.258	32.995	21.995	19.275	Continuing	Continuing

Note

Two new Leap Ahead initiatives started in FY 2016 - Forward Deployed Energy & Communications Outpost (FDECO) INP and Medium Displacement Unmanned Surface Vehicle (MDUSV) effort.

A. Mission Description and Budget Item Justification

This project addresses advanced technology development associated with providing the capability of Platform and Force Protection for the U.S. Navy. This project supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. For the new FY 2016 effort, Forward Deployed Energy and Communications Outpost (FDECO) INP, the project addresses advanced technology development associated with providing the undersea energy and communications infrastructure necessary to assure undersea dominance; extend the reach of undersea assets; enhance SA and standoff advantage without reducing forward presence and; provide endurance for unmanned systems necessary for force multiplication in an A2/AD environment. For the new FY 2016 effort, Medium Displacement Unmanned Surface Vehicle (MDUSV), the project will radically change the way the Navy does mine influence sweep, ASW and EW missions; it will introduce larger USVs to the Navy; and it will introduce advanced autonomy to the surface Navy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E)	13.106	13.487	17.546	0.000	17.546
Description: Activity includes: advanced technology demonstrations to evaluate emerging energy technologies and advanced technology development for Unmanned Sea Surface Vehicles in support of Naval S&T Focus Area on Autonomy and Unmanned Vehicles. The funding increase from FY2017 to FY2018 is due to added Vertical Launch System (VLS) reload at sea effort. The MDUSV and FDECO INP efforts are transferred to the new INP PE 0603801N Innovative Naval Prototypes effective FY2018. ***FY 2016 Accomplishments:*** - Continue all efforts of FY 2015. - Initiate the FDECO INP project. - Initiate Medium Displacement Unmanned Surface Vessel (MDUSV) effort to demonstrate the operational benefit of a highly autonomous, large USV with a modular payload capability and demonstrate at-sea three modular payloads. The activity will consist of advancements to autonomous control, payload integration, and at-					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603123N / *Force Protection Advanced Technology*	**Project (Number/Name)** 2912 / *Force Protection Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
sea demonstration of vessel autonomous control and payloads supporting mine warfare, anti-submarine warfare and electronic warfare. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Conduct advanced research related to critical S&T for development of autonomous navigation for Unmanned Sea Surface Vehicles from host ship. - Expand research for conducting advanced technology demonstrations to evaluate emerging energy technologies using Navy and Marine Corps facilities as test beds and evolving the Medium Displacement Unmanned Surface Vessel (MDUSV) effort to demonstrate the operational benefit of a highly autonomous, large USV with a modular payload capability and demonstrate at-sea three modular payloads. Initiate efforts to fund a prototype and operational demonstration of At-Sea Rearm of Vertical Launch System (VLS) capability in a relevant environment ***FY 2018 OCO Plans:*** N/A					
Title: AIRCRAFT TECHNOLOGY ***Description:*** The Aircraft Technology activity develops technologies for enhanced capability of Naval aviation aircraft platforms in terms of mission effectiveness, platform range, responsiveness, survivability, observability, readiness, safety and life cycle cost. It also develops new Naval air vehicle concepts and high impact, scalable Naval air vehicle technologies, such as - autonomous air vehicle command and control, helicopter and tiltrotor rotor drive systems, aerodynamics, propulsion systems, materials, structures and flight controls for future and legacy air vehicles. This activity directly supports the Naval Aviation Enterprise Science and Technology Objectives and the Naval Science and Technology Strategic Plan, principally in the Autonomy and Unmanned Systems, Platform Design and Survivability, Power and Energy and Total Ownership Cost Focus Areas. The funding increase from FY 2016 to FY 2017 is due to the increase investment in the joint Tactically Exploited Reconnaissance Node (TERN) effort and to maturation of Autonomous Aerial Cargo/Utility System (AACUS) technology from advanced research to advanced development.	26.661	32.226	6.022	0.000	6.022

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603123N / *Force Protection Advanced Technology*	**Project (Number/Name)** 2912 / *Force Protection Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The funding decrease in FY 18 is due to movement of the AACUS and Tern programs into the new Prototype PE 0603801N Innovative Naval Prototypes. ***FY 2016 Accomplishments:*** - Continued demonstration of initial core software, sensor, air vehicle and capability applications for Autonomous Aerial Cargo/utility System (AACUS). - Continued the advanced technology demonstration portion of the Variable Cycle Advanced Technology (VCAT) Program. Critical technology development efforts will begin with major engine manufactures and system contractors to develop/mature the highest priority, long lead propulsion system technologies, including variable/adaptive cycle engine components, for next generation carrier based Tactical Air (TACAIR) Intelligence, Surveillance and Reconnaissance(ISR) systems. - Continued VCAT Phase I variable cycle engine/propulsion subsystem technology development efforts through completion. - Demonstrated sensor improvements, capability expansion and technology maturation of the Autonomous Aerial Cargo/Utility System (AACUS). - Initiated the joint TERN program to conduct an at sea demonstration of Vertical Take-Off and Landing (VTOL) enabling technologies in support of DDG-51 and LCS-2 based future long endurance Unmanned Air Vehicle (UAV) capabilities. - Demonstrated portability to another rotary wing aircraft capability expansion and technology maturation of the Autonomous Aerial Cargo/Utility System. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. - Continue the AACUS program by demonstrating the capability to perform the assault support mission from mission request to final landing on a multiple delivery flight. ***FY 2018 Base Plans:*** - Continue the advanced technology development efforts and demonstrations of the Variable Cycle Advanced Technology (VCAT) Program. Critical technology development efforts continue with major engine manufactures and system contractors to develop/mature the highest priority, long lead propulsion system technologies, including variable/adaptive cycle engine components, for next generation carrier based Tactical Air (TACAIR) Intelligence, Surveillance and Reconnaissance (ISR) systems. ***FY 2018 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603123N / *Force Protection Advanced Technology*	**Project (Number/Name)** 2912 / *Force Protection Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Accomplishments/Planned Programs Subtotals	39.767	45.713	23.568	0.000	23.568

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall goals of this advanced technology program are the development of technologies which focus on the warfighter and providing the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage, while preserving operational capability. Overall metric goals are to transition the advanced technology projects into acquisition programs. Each Activity within this PE has unique goals and metrics, some of which include classified quantitative measurements. Specific examples of metrics under this PE include: - Advanced technology demonstrations to evaluate emerging energy technologies.

For the effort, Forward Deployed Energy and Communications Outpost (FDECO) INP, the overall goals of this advanced technology program are the development of technologies which focus on energy management and transfer technologies that enable persistent undersea operations by UxV Fleet; provide system architectures that are persistent, scalable and mission agile; provide communication and energy infrastructure available in degraded and contested environments and; provide a platform-agnostic solution that reduces development and maintenance costs. Overall metric goals are to transition the key advanced technology elements, Forward Deployed Energy (FDE), Forward Deployed Communications (FDC) and Forward Deployed Docking (FDD) into acquisition programs. Each Activity within this PE has unique goals and metrics, some of which include classified quantitative measurements. Specific examples of metrics include: - Advanced technology demonstrations to evaluate energy & data transmission and persistent connectivity.

Medium Displacement Unmanned Surface Vehicle (MDUSV), the objectives are to 1) Demonstrate, using specific payloads, the multi-mission versatility of MDUSV, and identify key interface requirements for future payloads. 2) Provide a robust assessment of MDUSV's COLREGs autonomy to build confidence in the reliability and safety of the autonomous control system and 3) Enable the evaluation of MDUSV's operational utility and design to support an acquisition transition decision.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603123N / *Force Protection Advanced Technology*	Project (Number/Name) 3049 / *Force Protection*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
3049: *Force Protection*	0.000	2.566	2.725	2.774	-	2.774	2.774	2.774	2.774	2.783	Continuing	Continuing

A. Mission Description and Budget Item Justification

Develop advanced technologies, critical to protecting naval installations, to provide seamless full spectrum protection against asymmetric attack by improving the ability to: detect and identify developing and immediate threats; shape our responses through improved situational awareness and decision making; shield personnel, mission critical facilities, infrastructure, and operating fleet assets; maintain essential functions; and sustain and restore critical services in the aftermath of an incident. Technologies developed will also seek to reduce the required manpower and skill levels devoted to the force protection mission.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: EMERGING THREATS	2.566	2.725	2.774	0.000	2.774
Description: This activity includes development of advanced technologies critical to protecting naval installations, and will provide seamless, full spectrum protection against asymmetric terrorist attack by improving the ability to: sense developing and immediate threats; shape our responses through improved situational awareness and decision making; shield personnel, mission critical facilities, infrastructure, and operating fleet assets; maintain essential functions; and sustain and restore critical services in the aftermath of an incident. Technologies developed will also seek to reduce the required manpower and skill levels devoted to the force protection mission.					
FY 2016 Accomplishments: - Continued development of lower cost/higher performance Force Protection sensors and automated detection algorithms, and decision support tools. - Continued research to reduce force protection manpower and equipment costs through automation and predictive learning algorithms. -Continued threat characterization research and perception experiments for sensor performance optimization and model development and validation. - Continued development of all weather sensors optimized for installation of force protection. - Continued research into sensors for use in counter-surveillance around protected facilities. - Continued research to advance sensor fusion capabilities in high density networks with diverse sensor grids. - Continued development of assessment algorithms and information analysis technologies to augment skills or replace persons in operations centers. - Continued interim demonstration of acoustic sensors for perimeter and area surveillance in realistic environments.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603123N / *Force Protection Advanced Technology*	**Project (Number/Name)** 3049 / *Force Protection*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of protection technology for naval installation power and energy infrastructure. - Continued expansion of research into sensors and countermeasures for use against unmanned underwater to include surface swimmers, underwater divers, and underwater diver propulsion aids. - Continued demonstration of multi-band electro-optical sensors and fusion algorithms in adverse weather conditions. - Initiated demonstration of sensors and countermeasures for use against underwater to include surface swimmers, underwater divers, diver propulsion aids, and underwater unmanned vehicles. - Initiated research in non-acoustic detection, tracking, classification, engagement of underwater threats to naval installations. - Initiated development of autonomous unmanned harbor defense systems for perimeter patrol and threat interdiction. -Initiated research into automated vehicle entry control point monitoring, automatic vehicle classification, risk assessment and logic system decision making. - Initiated development of non-contact biometric verification technologies to support unmanned automated access control systems. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Continue and expand development of Virtual Inductive Loop technology to include pedestrians, two wheeled vehicles, and multi-lane automated gates - Conduct interim demonstration of technologies for detection and classification of small unmanned threats to naval installations - Complete development and demonstration of electro-optic sensors and fusion algorithms for installation surveillance in adverse weather conditions. - Complete development and conduct demonstration of sensors and countermeasures for use against underwater threats to include surface swimmers, underwater divers, diver propulsion aids, and underwater unmanned vehicles. - Continue all other efforts not completed in FY 2017. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	2.566	2.725	2.774	0.000	2.774

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603123N / *Force Protection Advanced Technology*	**Project (Number/Name)** 3049 / *Force Protection*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall goal of this program is to develop technologies which will provide protection for our naval installations against asymmetric attack. Specific metrics include: a 50% reduction of manpower required to perform force protection surveillance, situational awareness, and decision making, a 2x improvement in electro-optical sensor performance in adverse weather conditions, a 50% reduction in sensor cost per square or cubic meter of detection at a given resolution, and a 50% reduction in false alarm rates for automated detection and tracking algorithms both on, above and below water.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603271N *I Electromagnetic Systems Advanced Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	32.924	26.421	9.360	-	9.360	8.804	9.556	8.056	8.217	Continuing	Continuing
2913: *Electromagnetic Systems Advanced Technology*	0.000	32.924	26.421	9.360	-	9.360	8.804	9.556	8.056	8.217	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 January 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this Program Element (PE) address technologies critical to enabling the transformation of discrete functions to network centric warfare capabilities, which simultaneously perform Radar, Electronic Warfare (EW), and Communications and Network functions across platforms through multiple, simultaneous and continuous communications/data links. The Electromagnetic Systems Advanced Technology program addresses Radio Frequency (RF) technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, Multi-Function sensor systems, and Position, Navigation and Timing (PNT) capabilities. Within the Naval Transformational Roadmap, this investment offers affordable options for the transformational capabilities required by the Sea Shield (Theater Air and Missile Defense), Sea Strike (Persistent Intelligence, Surveillance, and Reconnaissance), and ForceNet (Communications and Networking) SeaPower 21 Naval Warfighting Pillars.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603271N *I Electromagnetic Systems Advanced Technology*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	34.856	26.421	26.199	-	26.199
Current President's Budget	32.924	26.421	9.360	-	9.360
Total Adjustments	-1.932	0.000	-16.839	-	-16.839
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.974	0.000			
• SBIR/STTR Transfer	-0.958	0.000			
• Program Adjustments	0.000	0.000	-16.839	-	-16.839
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of EMC2 and NEMESIS Innovative Naval Prototype (INP) and Leap Ahead Technology (LA-Tech) program investments to the new INP PE 0603801N Innovative Naval Prototypes (INP) Advanced Technology Development.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603271N / *Electromagnetic Systems Advanced Technology*	Project (Number/Name) 2913 / *Electromagnetic Systems Advanced Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2913: *Electromagnetic Systems Advanced Technology*	0.000	32.924	26.421	9.360	-	9.360	8.804	9.556	8.056	8.217	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work in this project addresses cost-effective RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, Multi-Function sensor systems, and Position, Navigation and Timing (PNT) capabilities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: ELECTRONIC AND ELECTROMAGNETIC SYSTEMS	11.586	17.260	5.269	0.000	5.269
Description: The overarching objective of this activity is to develop, test, and demonstrate communications, electronic attack (EA), electronic surveillance (ES), electronic warfare (EW), and radar functions. This activity also includes development of affordable wideband, high performance Advanced Multifunction Radio Frequency (AMRF) apertures. A portion of this PE is devoted to mid-term technology development in close concert with acquisition programs of record. The products of these efforts are expected to transition at the end of their schedule into the associated acquisition program of record. a) Advanced EW Enabling Technologies - Develop classified advanced electronic warfare technology in support of current and predicted capability requirements. b) Electromagnetic Maneuver Warfare Command & Control (EMC2) (FY16-FY20) - Enable a battle group to work cooperatively in the EM Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), Communications (Comms) and Radar performance. EMC2 will build upon the Resource Allocation Manager (RAM) that was previously developed for single multifunction systems under the InTop program to optimize spectrum and functional use across a platform and an entire battle group. The increase from FY 2016 to FY 2017 reflects an increase in the level of effort for the new Electromagnetic Maneuver Warfare Command & Control (EMC2) Innovative Naval Prototype (INP) Program. The decrease from FY 2017 to FY 2018 reflects the realignment of the EMC2 Innovative Naval Prototype (INP) and Leap Ahead Technology (LA-Tech) designated program to PE 0603801N Innovative Naval Prototypes (INP) Advanced Technology Development where all of the INP/LA-Tech investments are being consolidated.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Advanced EW Enabling Technologies (formerly titled: Electronic Warfare (EW) Roadmap): - Continued development of classified advanced electronic warfare technology in support of current and predicted capability requirement. Electromagnetic Maneuver Warfare Command & Control (EMC2): - Initiated Wideband Airborne Multifunction System design. - Initiated Low-Band RF Intelligent Distribution Resource (LowRIDR) SubSystem build. - Initiated Electromagnetic Warfare Command and Control system design. ***FY 2017 Plans:*** Advanced EW Enabling Technologies: - Continue all efforts of FY 2016 unless noted as complete above. Electromagnetic Maneuver Warfare Command & Control (EMC2): - Continue all efforts of FY 2016 unless noted as complete above. ***FY 2018 Base Plans:*** Continue research in the areas of improved threat warning systems; electronic warfare support (ES); decoys and countermeasures against weapon tracking and guidance systems; electronic attack (EA) against adversary command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR); and electronic protection (EP) of our own weapons and C4ISR from intentional and unintentional interference to control the electromagnetic spectrum (EMS) by exploiting, deceiving, or denying enemy use of the spectrum while ensuring its use by friendly forces. ***FY 2018 OCO Plans:*** N/A					
Title: GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY	2.338	2.800	4.091	0.000	4.091
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Position, Navigation and Timing (PNT) capabilities using either GPS systems, non-GPS navigation devices, or atomic clocks. This activity will increase the operational effectiveness of U.S. Naval units. The focus is on the mitigation of GPS electronic threats, the development of atomic clocks that					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
possess unique long-term stability and precision, and the development of compact, low-cost, Inertial Navigation Systems (INS). The following are non-inclusive examples for projects funded in this activity. As a result of a comprehensive DOD wide assessment of current S&T investments in the area of Position, Navigation and Timing, funding was increased in FY 2018 in the Global Positioning System (GPS) & Navigation Technology thrust for increased investment in Assured Time Dissemination research. ***FY 2016 Accomplishments:*** GPS Anti-Jam Antennas and Receivers: - Continued GPS Antenna System for Enhanced electronic protection (EP), electronic surveillance (ES) and Precise Navigation. - Continued development of Small Antenna Based Anti-spoofing project. - Continued development of Advanced Spoofer Tracking. - Continued development of Next Generation Global Positioning Satellite System - Situational Awareness (XGPSS-SA) Challenged Environment. - Continued Modernized Receiver for RF Challenged Environments. - Continued development of the Simulation of GPS Signals in a Stressed Environment. - Continued development of Self Calibrating GPS Anti-Jam Antennas for Electronic Support. - Continued Cognitive Modernized GPS User Equipment (MGUE) for GPS-Denied Environments project. - Completed Modernized Integrated Spoofer Tracking. Precision Time and Time Transfer: - Continued DoD master clock time transfer via optical fibers. - Continued development of algorithms for distributed time scaling; developed architectures necessary to establish a Navy Global Coordinated Time Scale; tested the algorithms via both simulation and using actual clock data provided by the U.S. Naval Observatory (USNO). - Continued development and Distributing Time-frequency Device. - Continued development of Rb 3-cc Tactical Grade Atomic Clock (TGAC). - Completed Tactical Grade Atomic Clock Non-GPS Navigation Technology:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated Broadband Navigation Sonar (BBNS) Technology - Continued Mechanical System (MEMS) Inertial Navigation System (INS) Phase II project. - Continued Angle-Only Infra Red Celestial Navigation System. - Continued Optically Transduced MEMS Inertial Navigation System project. - Continued Sub-harmonic Lateral Mode MEMS Inertial Navigation System project. - Continued development of Wavewinds project. - Continued development of Small Unmanned Underwater Vehicle - Sonar Aided Inertial Navigation Technology (UUV-SAINT) project. - Continued development of Portable PCNS project. - Continued development of Alternative Navigation Over Unstructured or Featureless Terrain. - Continued Miniature Ultra-Cold Atom Chip Inertial Sensors. - Completed Two-Axis Gyro-compass Fiber Optic Inertial Navigation System. - Completed development of Superconducting Magnetometer On-Board Navigation (SIMON) System.					
FY 2017 Plans: GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2016 less those noted as complete. - Complete development of Small Antenna Based Anti-spoofing project. - Complete development of Next Generation Global Positioning Satellite System - Situational Awareness (XGPSS-SA) Challenged Environment. - Complete Modernized Receiver for RF Challenged Environments. - Complete development of the Simulation of GPS Signals in a Stressed Environment. - Complete development of Self Calibrating GPS AJ Antennas for Electronic Support. - Complete Cognitive Modernized GPS User Equipment (MGUE) for GPS-Denied Environments project. - Complete GPS Antenna System for Enhanced EP, ES and Precise Navigation. - Initiate advanced receiver design implementing advanced and collective acquisition and tracking techniques. Precision Time and Time Transfer: - Continue all efforts of FY 2016 less those noted as complete. - Complete development of algorithms for distributed time scaling; developed architectures necessary to establish a Navy Global Coordinated Time Scale; tested the algorithms via both simulation and using actual clock data provided by the U.S. Naval Observatory (USNO). - Initiate the development of generalized time transfer modem for terrestrial and shipboard systems.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate cold atom development efforts for compact, deployable next generation clock technology to surpass current Rubidium and Cesium standards, providing longer accurate time holdover in GPS denied environments. - Initiate RF and Optical time transfer effort for terrestrial, surface, and airborne platforms. Non-GPS Navigation Technology: - Continue all efforts of FY 2016 less those noted as complete. - Complete Optically Transduced MEMS Inertial Navigation System project. - Complete Sub-harmonic Lateral Mode MEMS Inertial Navigation System project. - Complete development of Wavewinds project. - Complete development of Small Unmanned Underwater Vehicle Sonar Aided Inertial Navigation Technology (UUV-SAINT) project. - Complete development of Portable PCNS project. - Complete development of Alternative Navigation Over Unstructured or Featureless Terrain. - Complete Two-Axis Fiber Optic Inertial Navigation System Phase II project. - Complete Mechanical System (MEMS) Inertial Navigation System (INS) Phase II project. - Initiate advanced development of geophysical, RF, and celestial navigation aids for manned and unmanned surface and subsurface platforms. - Initiate cold atom gravimetric measurement system for aids to inertial sensors.					
FY 2018 Base Plans: Continue advanced research and development in position, navigation and timing. This research aims to develop devices and systems that provide assured, cost-effective, and mission relevant PNT to the warfighter. Areas of investment included robust GPS, non-GPS navigation aids, and assured timekeeping. Specifically, research in GPS Anti-Jam Antennas and Receivers for Navy platforms for the purpose of providing precision navigation capabilities in the presence of electronic threats and anti-spoofer/anti-jam processors for the purpose of providing precision navigation capabilities in the presence of emergent threats; Tactical grade atomic clocks that possess unique long-term stability and precision for the purpose of providing GPS-independent precision time and transferring GPS-derived time via radio frequency links for the purpose of providing GPS-independent precision time; and Inertial navigation systems for the purpose of providing an alternative means of providing precision navigation, a correlation navigation technique using earth maps of high precision, for those Naval platforms which may not have GPS navigation capabilities and/or loss of GPS signals.					
FY 2018 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: INTEGRATED TOPSIDE (INTOP) INNOVATIVE NAVAL PROTOTYPE (INP)	10.000	0.000	0.000	0.000	0.000
Description: The overarching objective of the Integrated Topside (INTOP) INP is to develop and demonstrate a set of prototypes that integrate RF functionality (EW, Radar, Communications, Navigation) into a common set of multi-function apertures electronics and software through an architecture that is modular, scalable across all platforms, and open at the RF as well as computer and software level. The apertures are capable of providing multiple simultaneous, independent beams which can together perform any of the above functions. The major objectives of this activity are: a) Submarine SATCOM Array - Develop wide-band SATCOM array capable of supporting EW for submarines. b) Electronic Warfare (EW)/Information Operations (IO)/Line of Sight (LOS) Communications (Comms) for Surface Combatants - Develop wide-band array to support EW capability and other functions, including but not limited to IO and LOS Comms, for surface combatants with potential application to other platforms. c) Architecture, Standards and Devices - Develop architecture and standards for wide-band multi-beam, multi-band arrays and below deck systems and the technology and electronic devices needed to make integrated array systems affordable. d) Surface Combatant Communication Array - Develop wide-band surface combatant communication array capable of supporting other RF functions. e) Resource Allocation Manager - Develop enterprise common Resource Allocation Manager. f) Digital Radar - Develop an all digital radar to demonstrate advanced concepts for coherent radar networking and control, which will increase radar coverage and provide new levels of electronic protection (EP), while maximizing radar resources and reducing cost. g) Low Band Communications, IO and EW - Develop low band technology development and concept studies leading to development of an Advanced Development Model (ADM).					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Resource Allocation Manager: - Completed integration and test of Resource Allocation Manager (RAM). Digital Radar: - Completed system build for front-end. - Completed system build for back-end. Low Band Communications, Electronic Warfare (EW) and Information Operations (IO): - Continue and complete development of the initial architecture and requirements. - Completed subsystem designs. ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Title: NEMESIS ***Description:*** The objective is to develop a System of Systems (SoS) able to coordinate distribute electronic warfare (EW) resources against many adversary surveillance and targeting sensors simultaneously. It will benefit the warfighter by providing platform protection across the battlespace against many sensors, creating seamless cross-domain countermeasure coordination, and enabling rapid advanced technology/capability insertion to counter emerging threats. a) Develop reconfigurable and modular EW payloads, Distributed Decoy and Jammer Swarms (DDJS), effective multi-spectral countermeasures (CM), and Multiple Input/Multiple Output Sensor/CM (MIMO S/CM) for platform protection across operational domains.	9.000	6.361	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
This R2 activity was initiated in PE 0602271N Electromagnetic Systems Applied Research and expanded in FY 2015 to PE 0603271N Electromagnetic Systems Advanced Technology. The decrease from FY16 to FY17 reflects the transition toward the integration and demonstration of the new technologies. The decrease from FY 2017 to FY 2018 reflects the realignment of the NEMESIS Innovative Naval Prototype (INP) and Leap Ahead Technology (LA-Tech) designated program to PE 0603801N Innovative Naval Prototypes (INP) Advanced Technology Development where all of the 6.3 INP/LA-Tech investments are being consolidated. ***FY 2016 Accomplishments:*** - Continued development and demonstration of the NEMESIS Electronic Warfare (EW) payloads and their integration into platforms. - Continued application of the research supporting distributed control, coordination and networking of NEMESIS payloads and platforms. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	32.924	26.421	9.360	0.000	9.360

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603271N / *Electromagnetic Systems Advanced Technology*	**Project (Number/Name)** 2913 / *Electromagnetic Systems Advanced Technology*

E. Performance Metrics

Advanced Electronic Sensor Systems for Missile Defense and Long Range Detection and Tracking ECs are aligned to the Navy's Advanced Cruiser (CG(X)) plans and closely coordinated with Naval Sea Systems Command Integrated Warfare Systems (PEO IWS 2.0). Other performance metrics are discussed within the R-2a. Navigation and timekeeping developments are aligned and coordinated to the OPNAV (N2N6E4) Assured PNT plan for surface and aviation platforms and with the Special Programs office's technology development roadmap.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603640M *I MC Advanced Technology Demo*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	128.386	140.416	154.407	-	154.407	142.368	143.568	142.368	145.215	Continuing	Continuing
2223: *Marine Corps ATD*	0.000	86.525	93.355	94.664	-	94.664	94.925	95.176	93.976	95.855	Continuing	Continuing
2297: *Futures Directorate*	0.000	41.861	47.061	59.743	-	59.743	47.443	48.392	48.392	49.360	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 January 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps) to include specific Marine Corps objectives defined by the United States Marine Corps (USMC) S&T Strategic Plan. It provides the vision and key objectives for the essential S&T efforts that will enable the continued supremacy of United States Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. Expeditionary Force 21 (EF 21) is the Marine Corps' foundational Capstone Operating Concept that guides capability development, wargaming, and experimentation and this PE. EF 21 aligns with national strategic guidance including the National Security Strategy (NSS), National Military Strategy (NMS), Defense Strategic Guidance (DSG), Quadrennial Defense Review (QDR), and with Naval strategy in the Department of the Navy's Cooperative Strategy for 21st Century Seapower.

EF 21 describes a future Marine Corps ground force that will have cornerstone characteristics of being naval, expeditionary, agile, and lethal. This force will face security environments and threats driven by Complex Terrain (to include informational and human aspects), Technology Proliferation (including precision weapons), Information used as a Weapon, Battles of Electromagnetic Spectrum Signatures, and Increasingly Contested Maritime Domains. The future Marine Corps will be designed to meet those future security environments but needed force characteristics also impose constraints and challenges on required capabilities. An example would be a need to conduct Information Warfare but with systems constrained by size, weight, and power considerations necessary for a naval and expeditionary force. Another example is Marine firepower requirements to be lethal against technologically comparable threat systems but Marine capabilities and weapons constrained by deployment and sustainment challenges of naval shipping and a distributed expeditionary force. These capability constraints and challenges in turn drive unique S&T requirements that define this PE.

S&T projects in this PE enable future force capabilities through advanced technology development to meet Marine needs within the unique constraints described above in the warfighting functional areas of: Command, Control, Communications, Computers (C4); Intelligence, Surveillance, and Reconnaissance (ISR); maneuver and mobility; force protection; logistics and sustainment; human performance, training, and education; firepower; and Expeditionary Cyber. This PE funds advanced technology development, technology demonstrations, assessment of emerging technologies, experimentation in warfighting concepts, and the Future Naval Capability (FNC) process as means to develop unique Marine future capabilities with new S&T.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603640M *I MC Advanced Technology Demo*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	131.490	140.416	142.407	-	142.407
Current President's Budget	128.386	140.416	154.407	-	154.407
Total Adjustments	-3.104	0.000	12.000	-	12.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.104	0.000			
• Program Adjustments	0.000	0.000	12.000	-	12.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603640M / *MC Advanced Technology Demo*	Project (Number/Name) 2223 / *Marine Corps ATD*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2223: *Marine Corps ATD*	0.000	86.525	93.355	94.664	-	94.664	94.925	95.176	93.976	95.855	Continuing	Continuing

A. Mission Description and Budget Item Justification

Critical Marine Corps requirements/imperatives addressed in this Project are: Maneuver; Force Protection; Human Performance, Training and Education; Logistics; Command, Control, Communications and Computers (C4); Intelligence, Surveillance and Reconnaissance (ISR) , Expeditionary Cyber and Firepower. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment. Multiple transitions into the Sub-system/ Component Advanced Development Phase are planned, as well as fieldable prototyped to reduce risk in System Concept Development and Demonstration. A tactically effective Mine Countermeasures (MCM) capability is vital to Force Protection and necessary if Maneuver on land is to become a functional component of Naval Expeditionary Maneuver Warfare. Maneuver, supported by MCM provides synchronization and speed of detection, breaching, clearance, proofing, and marking operations. This project supports: 1) engaging regional forces in decisive combat on a global basis; 2) responding to all other contingencies and missions in the full spectrum of combat operations (high, middle, and low intensity), in Military Operations in Urban Terrain (MOUT), and in Operations other than War (OOTW); and 3) warfighting experimentation. By providing the technologies to enable these capabilities, this project supports the goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment.

In addition, this project supports the goals and objectives of the Naval Future Naval Capabilities Program. The USMC Future Naval Capabilities Activity, formerly named Littoral Combat/Power Projection (LC/PP), addresses the advanced technology development associated with the Marine Corps' participation in the Department of the Navy's (DoN) Future Naval Capabilities (FNC) Program. The eight Expeditionary Warfighting Areas support the the Technology Maturation portfolio investment. The USMC FNCs support the Technology Maturation/Acquisition Enabler investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS (C4)	6.167	6.950	7.500	0.000	7.500
Description: This activity integrates and demonstrates enhanced communications and situational awareness in warfighting environments and communication and situational awareness technologies for near term USMC operations. The focus is on development and leveraging advanced C4 technologies to enable enhanced Distributed Operations, Irregular Warfare, and Marine Corps Expeditionary Warfare. Specifically, the C4 Thrust intends to demonstrate markedly improved capabilities in over-the-horizon (OTH), beyond line-of-sight, and restricted environment communications; mobile networking; tactical decision making; tactical situational awareness; and small unit position location and navigation. Advanced technology resources will be applied to complement commercial, other service, and defense agency investments to produce a technology base to address identified Marine Corps technology gaps.					
FY 2016 Accomplishments:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued urban navigation with limited Global Positioning System availability demonstrations. - Continued demonstrations of improved urban communications capabilities. - Continued developing tailored tactical Human to Machine Interfaces aligned to primary operational functions and non-intrusive within the battlespace. - Continued creating services for the tactical network that are fully operable with Distributed Common Ground System (DCGS) and the DCGS Integration Backbone. - Continued Application-Network Architectures, Conformal Antenna Integration and Demonstration Spiral 2 and C3 for the Individual Marine Spiral Two. - Continued Application Network Architecture and Automated Small Unit Decision Tools. - Continued Advanced Communications Systems and Small Unit C3. - Continued smart radio efforts. - Continued Tactical Cyber Warfare. - Continued Networking On-The-Move Technology insertion. - Completed mobile security. - Initiated MAGTF C2 Technology insertion.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete demonstrations of improved urban communications capabilities. - Complete Application-Network Architectures, Conformal Antenna Integration and Demonstration Spiral 2 and C3 for the Individual Marine Spiral Two. - Complete Application Network Architecture and Automated Small Unit Decision Tools. - Complete urban navigation with limited Global Positioning System availability demonstrations - Complete Advanced Communications Systems and Small Unit C3. - Initiate an Advanced HF Antenna effort.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Initiate Advanced Cryptography Technology. - Initiate Adaptive Distributed Messaging. - Transfer all Tactical Cyber Warfare efforts to the Expeditionary Cyber Activity.					
FY 2018 OCO Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: FIREPOWER	9.061	8.521	8.558	0.000	8.558
Description: This activity develops technology for application on current and future expeditionary weapons and elements of the kill chain. It includes, but is not limited to, the following technologies: fuze, fire control, launch/ propulsion, lethality, and accuracy. ***FY 2016 Accomplishments:*** - Continued development of targeting and engagement technologies for distributed operations collaborative fires integration and demonstrations. - Continued design, development, prototyping and testing of lightweight technologies that provide individual Marines enhanced capabilities to detect and identify man-size targets out to at least the maximum effective range of their personal weapons during all conditions (daylight, limited visibility, & darkness) by integrating multiple capabilities into a single system. - Continued Engineering and Development portion of Awareness for Lightweight Engagements and Remote Targeting (ALERT) to develop large aperture, lightweight lens with enhanced fields of view. - Continued the Engineering and Development portion of Semi-Autonomous Fires Technology (SAFT) to develop semi-autonomous fire control systems for use in next generation remote weapons systems, to enhance performance and minimize gunner/operator burden. - Continued investigation of the scalability of variable effects conventional munitions, gun, and propulsion technologies for improving firepower effectiveness while increasing affordability and decreasing logistics burden in support of expeditionary warfare. - Continued development of precision fires engagement technologies, to include trajectory shaped 81mm mortars, 83mm missiles, and smaller precision munitions. - Initiated High Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) to include projectile integration, lethality enhancement, fuze setting integration and aerodynamic and aerospace technologies. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate the advanced technology portion of Caseless, Lightweight, Low-volume Round (CLLVR) to develop lightweight, small caliber ammunition for individual, crew served, and remotely mounted weapons. ***FY 2018 OCO Plans:*** N/A					
Title: FORCE PROTECTION	9.519	10.720	10.043	0.000	10.043
Description: This activity supports the Force Protection Thrust's Advanced Technology Demonstration efforts in the areas of individual Marine platforms, equipment and autonomous systems. This includes technologies to enable detection, neutralization, breaching, and clearing of explosive hazards from the beach exit to inland objectives. Efforts supported under Force Protection also include the demonstration of technologies such as Air Defense/Counter Rocket, Artillery, and Mortar (CRAM) and counter tactical surveillance and targeting, including pre-shot sniper detection, technologies in support of maneuver warfare, small unit distributed operations, and technologies for improved Personnel Protective Equipment for individual protection against blast, ballistic, and blunt impact threats. ***FY 2016 Accomplishments:*** - Continued development of technologies to defeat side/top attack and advanced fuze mines through signature reduction and advanced signature duplication. - Continued development of technologies to locate and defeat IEDs. - Continued development of technologies to defeat advanced mine fuzes (seismic, acoustic, and infrared). - Continued Warfighter modeling and simulation efforts for the Warfighter-as-a-System analysis approach and methodology combining survivability, mobility, and warfighter performance parameters. - Continued demonstration of laser technology readiness for battlefield employment. - Continued physics-based characterization of signatures of proud/buried targets/explosive hazard indicators across the spectrum of applicable detection modalities using knowledge/investigation of target physics. - Continued a program to demonstrate the fusion of multiple modes of detection of explosive hazards into a single system. - Continued development of advance modular and scalable personal protective equipment utilizing advances in mobility/survivability modeling and simulation, materials, and bio-fidelic surrogates. - Continued development of materials and helmet systems that absorb/dissipate blast shock waves. - Continued an advanced technology demonstration for modular mission packages for the detection, neutralization, marking and reporting of explosive hazards using multiple, existing vehicles in movement to contact and amphibious raid scenarios.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued an advanced technology demonstration for autonomous vehicles in the detection, neutralization, marking and reporting of explosive hazards using multiple, existing vehicles in movement to contact and amphibious raid scenarios. - Continued an advanced technology demonstration that detect and classify tactical surveillance and targeting threats before engagement from a moving platform. - Continued an integrated technology demonstration to develop a system of systems that addresses route reconnaissance and clearance for a Marine Expeditionary Unit(MEU). - Continued a project to develop organic technology solutions for the detection and clearance of explosive hazards and obstacles encountered by Marine Corps forces during amphibious operations. - Continued a project to investigate the detection and neutralization of explosive hazards in multiple, diverse, environments. - Continued a program to fuse multiple technologies that will detect and classify tactical surveillance and targeting threats before engagement from a moving platform. - Continued projects to develop Personnel Protection Equipment (PPE) through novel Modular, Tailorable and scalable design concepts which increase survivability and operational suitability to the warfighter. - Continued broad based material (ceramics, fiber and Fiber Re-Enforced Plastics) to demonstrate the possibility of significant weight reductions (greater than 50%) can be achieved. - Completed Anti-Tank Guided Missile (ATGM) effort to defeat ATGMs in complex urban environment.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete a program to fuse multiple technologies that will detect and classify tactical surveillance and targeting threats before engagement from a moving platform. - Complete development of materials and helmet systems that absorb/dissipate blast shock waves. - Initiate an advanced technology demonstration that uses Warfighter modeling and simulation efforts and advanced materials to create, test, and evaluate modular and scalable personal protective equipment.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete Warfighter modeling and simulation efforts for the Warfighter-as-a-System analysis approach and methodology combining survivability, mobility, and warfighter performance parameters. - Complete an advanced technology demonstration that detect and classify tactical surveillance and targeting threats before engagement from a moving platform.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete an integrated technology demonstration to develop a system of systems that addresses route reconnaissance and clearance for a MEU. - Complete development of advance modular and scalable personal protective equipment utilizing advances in mobility/survivability modeling and simulation, materials, and bio-fidelic surrogates. - Complete projects to develop Personnel Protection Equipment (PPE) through novel Modular, Tailorable and scalable design concepts which increase survivability and operational suitability to the warfighter. - Complete broad based material (ceramics, fiber and Fiber Re-Enforced Plastics) to demonstrate the possibility of significant weight reductions (greater than 50%) can be achieved. ***FY 2018 OCO Plans:*** N/A					
Title: HUMAN PERFORMANCE, TRAINING & EDUCATION	12.352	13.207	6.833	0.000	6.833
Description: This activity addresses the applied research effort of the Human Performance Training and Education thrust (HPT&E). The HPT&E thrust investment profile is directed at two technology investment areas, Warrior Resilience, and Decision Making and Expertise Development. Warrior Resilience efforts are focused on advanced training technologies and methodologies that enhance neural, cognitive, and physical readiness. Decision Making and Expertise Development efforts are focused on training and education technologies and methodologies that accelerate the development and improve the retention of skills in decision making, situation awareness, and individual and team adaptability and coordination on decentralized, dynamic and dispersed battlefields. The FY2017 to FY2018 decrease in HPT&E investment is due to completion of an agent-based surrogate instructor development environment (ASIDE), the acceleration and completion of a Marine augmented classroom environment (ACE) effort that will enhance instructors' teaching performance training to optimize the use of resilience skills (TOURS) and the completion of the USMC Basic School's project to test the efficacy of simulation based training in the school's curriculum. ***FY 2016 Accomplishments:*** - Continued the development of small-unit training for adaptability and resiliency in decision making (SUDM), to enhance the Marine Air Ground Task Force's capabilities by training and equipping small-unit leaders to handle the demanding complexities and possess the adaptive mindset necessary to operate across the spectrum of conflict; empowering our strategic corporals as well as all of our junior leaders to fight, operate, and win in this challenging security environment.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued design and development of a Marine augmented classroom environment (ACE) that will enhance instructors' teaching performance and student learning outcomes. - Continued design and development of a test-bed and conduct The Basic School evaluation to test the efficacy of simulation based training in that curriculum. - Continued development and demonstrate an agent-based surrogate instructor development environment (ASIDE) to allow USMC to field small-team focused intelligent training solutions. - Continued development of an individualized fatigue countermeasure training tool for Marines that will provide increased fatigue resilience training effectiveness, improved fatigue management and reduced fatigue-related operational errors. - Continued development of a master instructor development system (MIND) which will provide measurement framework to support the development of master instructors by creating a developmental model of instructor mastery. - Completed the development of training to optimize the use of resilience skills (TOURS), specifically develop and iterate training modules for relapse prevention, deployable refresher training, supports for transfer climate and social support for small unit leaders. - Completed design and development of methods for establishing optimal training intervals for the Marine Corps Martial Arts Program (MCMAP) for improvement in physical performance and warrior mindset. - Initiated the development of measures of training effectiveness that connect training tasks with measures of performance under various stressors.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete design and development of a test-bed and conduct The Basic School evaluation to test the efficacy of simulation based training in that curriculum. - Complete development and demonstrate an agent-based surrogate instructor development environment (ASIDE) to allow USMC to field small-team focused intelligent training solutions. - Complete design and development of a Marine augmented classroom environment (ACE) that will enhance instructors' teaching performance and student learning outcomes. - Initiate a holistic model solution that leverages previous efforts in warrior resilience and fitness to enhance performance and mitigate injuries at the infantry small unit level.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete development of an individualized fatigue countermeasure training tool for Marines that will provide increased fatigue resilience training effectiveness, improved fatigue management and reduced fatigue-related operational errors. - Complete development of a master instructor development system (MIND) which will provide measurement framework to support the development of master instructors by creating a developmental model of instructor mastery. - Initiate adaptive training techniques to support training efficacy and efficiency. ***FY 2018 OCO Plans:*** N/A					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) ***Description:*** This activity supports the demonstration of technologies to enhance situational awareness and tactical decision making through automated analysis, fusion of data, rapid integration of information, and acquired knowledge resulting in actionable intelligence at the lower command levels. The activity includes the demonstration of ISR efforts involving enhanced reconnaissance and persistent surveillance, and sensors for unmanned ground and aerial vehicles. Advanced Technology demonstrations also include the collection of information [monitoring, sensing, and locating] in the 3D urban battlespace as well as exploiting information [identifying and classifying data] as part of the intelligence preparation of the battlespace in order to facilitate operational maneuver and distributed operations. The FY2017 to FY2018 increase in the ISR Activity funding is due the initiation of research on deriving node and network signatures that are predictive of future behavior by modeling node attributes, interactions and the content of published communication and the initiation of research on applying recommendation theory to assist the effectiveness of intelligence and operations staffs. ***FY 2016 Accomplishments:*** - Continued research on the development of automated data tagging algorithms that enable connected graphs of structured and unstructured data. - Continued technology development required to enable tactical UAS on-board processing of terabytes of data in real time. - Continued development of a user composable search and display capability enabled by map reduce technology.	4.576	5.170	7.829	0.000	7.829

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued project to improve the enterprise recognition of critical tactical information relevant to real-time mission execution. - Continued research on technologies needed to tailor information delivery to warfighters based on mission context and user preferences. - Continued project to demonstrate the feasibility of analytic populated big data architectures to populate and maintain a global knowledge environment relevant to rapid turn amphibious mission planning. - Continued project to develop a set of video analytic classifiers (entity, behavior, and scene) that can run in a power efficient manner in embedded hardware. - Continued project to improve expeditionary force capabilities to discover and process data across integrated cross domain systems. - Continued project to enable the synchronized planning and management and ISR assets given a set of disparate mission information requirements. - Continued project to enhance the extraction of target quality information from unregistered unstructured images and imagery. - Continued effort to automate the design and conduct of use cases relevant to tactical information requirements. - Continued research to develop a capacity to run tracklet fusion, track analysis and data to track or track to track correlation as a distributed service run as a map-reduce job, both forensically and in real time. - Continued research to develop a prototype system capable of maintaining the entity models needed for entity co referencing during real time natural language processing workflows. - Continued research on the development of a capability to automate the extraction of video events relevant to mission information needs in real time on power efficient hardware. - Continued research on implementing orchestrated advanced analytics running across cloud and non-cloud based architectures. - Completed new Actionable Intelligence for Expeditionary and Irregular Warfare efforts which include Human Network Decision Modeling and the fusion across modeling approaches to increase prediction accuracy. - Completed the development of a workflow manager capable of cloud service discovery and configuration. - Completed Tagging, Tracking, and Locating efforts to demonstrate a system that will automatically translate large amounts of wide area surveillance data into tracks, useful to expose entity to entity associations; build urban context, as well as detect events and anomalies; and associate objects, tasks, locations and events for creating actionable intelligence. - Completed research to develop concept based information retrieval from unstructured data sources based on structured grammars or intensity vectors.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiated project to optimize the collection planning process through automation by automatically generating sensor plans, automating the production of information products, and delivering the most relevant information to the warfighters to enable rapid response in an evolving intelligence environment. - Initiated project to develop a capability to automatically deliver mission relevant information to an agile tactical unit based on mission ontologies, user preferences and high level descriptions of information needs. - Initiated project to develop a capability that will track and enhance mission readiness enabled by a dynamic machine understanding of mission information needs, a matured sensor optimization ability and operations research applied to course of action analysis. - Initiated the development of level 1 and level 2 fusion capabilities applied to complex graphs. - Initiated the development of cost functions for predictions made from data embedding spaces. - Initiated the development of complex event detection that is informed by entity pedigree.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete research on the development of automated data tagging algorithms that enable connected graphs of structured and unstructured data. - Complete technology development required to enable tactical UAS on-board processing of terabytes of data in real time. - Complete research to develop a capacity to run tracklett fusion, track analysis and data to track or track to track correlation as a distributed service run as a map-reduce job, both forensically and in real time. - Complete research to develop a prototype system capable of maintaining the entity models needed for entity co referencing during real time natural language processing workflows. - Complete research on technologies needed to tailor information delivery to warfighters based on mission context and user preferences. - Complete project to enhance the extraction of target quality information from unregistered unstructured images and imagery. - Initiate the development of a knowledge informed workflow manager capable of generating workflows automatically in response to alert conditions. - Initiate the development of power efficient neuro inspired algorithms for machine understanding.					
FY 2018 Base Plans: - Continue all efforts of FY 2017, less those noted as completed above. - Complete project to improve expeditionary force capabilities to discover and process data across integrated cross domain systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete development of a user composable search and display capability enabled by map reduce technology. - Complete project to improve the enterprise recognition of critical tactical information relevant to real-time mission execution. - Complete research on the development of a capability to automate the extraction of video events relevant to mission information needs in real time on power efficient hardware. - Complete research on implementing orchestrated advanced analytics running across cloud and non-cloud based architectures. - Complete the development of complex event detection that is informed by entity pedigree. - Initiate research to derive node and network signatures from node attributes, interactions and published communications, and causality between topics and sentiments to enable prediction of future behavior and events. - Initiate research on applying recommendation theory to assist the effectiveness of intelligence and operations staffs. ***FY 2018 OCO Plans:*** N/A					
Title: USMC FUTURE NAVAL CAPABILITIES ***Description:*** This R-2 Activity, formerly named Littoral Combat/Power Projection (LC/PP), addresses the advanced technology development associated with the Marine Corps' participation in the Department of the Navy's (DoN) Future Naval Capabilities (FNC) Program. Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0603673N Future Naval Capabilities Advanced Technology Development, where the Navy's participation in the FNC Program is funded. The FNC Program represents the requirements-driven, delivery-oriented portion of the DoN Science and Technology (S&T) portfolio. FNC investments respond to Naval Technology Gaps generated by Integrated Process Teams (IPTs) that are co-managed by Navy and the Marine Corps flag/general officers with representation across the naval research enterprise. FNC funding is aligned to naval challenges that may be associated with any of the FNC focus areas (i.e., Pillars). FNCs contain both 6.2 Applied Research and 6.3 Advanced Technology Development Budget Activity (BA) components as technology is matured from a Technology Readiness Level (TRL) of 3 or 4 to a TRL of 6.	18.255	20.150	26.803	0.000	26.803

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The FY 2017 to FY 2018 increase in the USMC Future Naval Capabilities Activity is due to realigning funds within the PE for the initiation of the Fuel Efficient Technology Suite and Water Speed Enhancement efforts in FY 2018. ***FY 2016 Accomplishments:*** - Continued development of wide area surgical and persistent surveillance technologies (WASPS). - Continued Automated Processing for Spectral Exploitation and Dissemination (APSED) - Integrate and conduct laboratory tests of air-to-ground embedded processing capabilities. - Continued Compact Wide Area Reconnaissance and Spectral Sensor (CWARSS) - Finalize the design of the multi-access hardware architecture to accommodate Electro-Optic/Infra-Red (EO/IR) and hyperspectral sensors. - Continued development of spectral and reconnaissance imagery for tactical exploitation (SPRITE). - Continued Target Processing Center (TCP) Radar/Context Fusion by developing and testing algorithms to amplify or dampen threat surfaces based on Rules of Engagement (ROE). - Continued Target Processing Center (TCP) Radar Fusion and False Track Mitigation - Test and improve radar fusion and false track mitigation technologies within a relevant environment. - Continued development of the Ground Based Air Defense On-the-move high energy laser demonstrator (GBAD). - Continued Data Conditioning - Develop pattern recognition algorithms that can work against large Ground Moving Target Indicator (GMTI) data sets. - Continued Network Adaptive Communication Services - Develop gateway-mediated exchange mechanisms for existing or new gateways, and information sources using network awareness and multi-mode protocol adaptations. - Completed development of technologies to enable the exchange of actionable information at the tactical edge. - Completed development of the Azimuth and Inertial MEMS Navigation System (AIM). - Completed development and transition of Expeditionary Fighting Vehicle(EFV) obstacle detection capability to EFV Direct Reporting Program Manager (Expeditionary Fighting Vehicle Obstacle Avoidance System (EFVODS)). - Completed the development of algorithms capable of improving the accuracy of the threat picture in a targeting processing center. - Completed development of modular scalable effects prototype weapon. - Completed development of tactical urban breaching technologies. - Completed development of counter improvised explosive devices technologies.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed development of advanced survivability and mobility technologies for Marine Corps tactical and combat vehicles. - Completed development of technologies to lighten the load of warfighters by 1) reducing the weight of and improving the capability of the day/night weapon sight, 2) eliminating battery incompatibility, and 3) providing Graphical User Interface (GUI-based) software for tradeoff analyses based on Military Operational Posture. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as completed above. - Continue development of Densified Propellant Fire From Enclosure/Enclosed Space (DP FFE/CS)enabling capability; specifically the analysis to incorporate tungsten into the SMAW Block 2 rocket motor propellant to decrease the detrimental effects of launch back-blast and over-pressure in confined spaces. (Effort was previously funded by PE 0603673N Future Naval Capabilities Advanced Technology Development) - Complete EMW-FY12-03 Wide Area Surgical And Persistent Surveillance (WASPS). - Complete SHD-FY13-02 Ground Based Air Defense On-The-Move (GBAD). - Initiate development of Advanced Topcoat System - Ground Vehicle Enabling Capability (EPE-FY16-01); specifically the formulation development of a high performance, zero-isocyanate Chemical Agent Resistant Coating (CARC) system that provides enhanced corrosion resistance and improved operational functionality on ground vehicle platforms. - Initiate the development of a high reliability distributed fuzing system for the 155mm DPICM projectile. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete Densified Propellant Fire From Enclosure - Confined Space (FFE/CS) Propulsion Technologies - Test and demonstrate the final system configuration from the Shoulder-Launched Multipurpose Assault Weapon (SMAW) and prepare a Level 2 drawing package. - Initiate EMW-FY18-01 ACV 1.X Fuel Efficient Technology Suite - Conduct a drive-cycle and component-characterization analysis of alternatives to determine optimum gains for various technology pairings. - Initiate EMW-FY18-01 Marine Corps portion of ACV 1.X Water Speed Enhancement (this effort is co-funded in PE 0603673N Future Naval Capabilities Advanced Technology Development) - Estimate seaway loads to feed the hull design and conduct material studies and testing to identify the most promising materials. ***FY 2018 OCO Plans:*** N/A					
Title: LOGISTICS	13.160	14.061	9.500	0.000	9.500

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: This activity supports Marine Corps Expeditionary Logistics which is the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. Expeditionary Logistics replaces mass with assured knowledge and speed, is equally capable ashore or afloat in austere environments, and is fully scalable to meet uncertain requirements. Expeditionary Logistics logically divides into four pillars: efficient and responsive force sustainment, planning and directing logistics operations, logistics demand reduction, and fleet maintenance. These pillars are thoroughly integrated and perpetually related in execution. The FY 2017 to FY2018 decrease in the Logistics Thrust Activity is due to the completion of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain, as well as the completion of multiple energy related projects to include storage and hybrid smart grid technologies. ***FY 2016 Accomplishments:*** - Continued analysis of material alternatives for automated vehicle health monitoring and reporting. - Continued demonstration of advanced concepts for mobile infrastructure. - Continued efforts to improve advanced electrical power generation from fuel cells and renewable sources as well as to improve the efficiency of conventional generation via hybridization and smart-grid technologies. - Continued integration and demonstration of advanced materials to reduce maintenance into selected vehicle and machinery components. - Continued the development of robotic systems to facilitate the packaging and handling of logistic supplies. - Continued a field demonstration of renewable energy devices and deployable equipment showing fewer liabilities when delivering expensive fuel, thereby lowering Marine Corps operational costs. - Continued operations research and analysis efforts to enhance seabased expeditionary supply chain concepts and technologies. - Continued development of alternative (non-electrochemical) energy storage technologies for hybrid power system load management. - Continued development of low energy desalination technologies to allow for efficient salt-water purification at the small/individual scale. - Continued the development of anti-fouling and non-fouling water purification components to enable enduring performance of small water purification systems.					

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Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2223 / *Marine Corps ATD*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued the development of real-time water quality monitoring systems for use with small scale water purification systems. - Continued the development of efficient water packaging and distribution technologies. - Completed exploring the development of portable fuel cell technologies capable of providing Power in the 100 Watt to 500 Watt power range. - Completed integration and demonstration of electrochemical ultracapacitors into hybrid electric power systems. - Initiated development of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain. - Initiated the development of modular thermoacoustic systems capable of acting as power generation or heat-pump devices. - Initiated the development of alpha-particle semiconductors to harness energy from alpha-emitting materials and create ultra-high energy density nuclear batteries. - Initiated the development of ultra-high efficiency piezoelectric devices. - Initiated the development of intelligent microgrid systems for the expeditionary unit.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above. - Complete integration and demonstration of advanced materials to reduce maintenance into selected vehicle and machinery components. - Complete analysis of material alternatives for automated vehicle health monitoring and reporting. - Complete demonstration of advanced concepts for mobile infrastructure. - Complete the development of robotic systems to facilitate the packaging and handling of logistic supplies. - Complete efforts to improve advanced electrical power generation from fuel cells and renewable sources as well as to improve the efficiency of conventional generation via hybridization and smart-grid technologies. - Complete operations research and analysis efforts to enhance seabased expeditionary supply chain concepts and technologies. - Complete development of alternative (non-electrochemical) energy storage technologies for hybrid power system load management. - Complete a field demonstration of renewable energy devices and deployable equipment showing fewer liabilities when delivering expensive fuel, thereby lowering Marine Corps operational costs. - Complete development of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete the development of modular thermoacoustic systems capable of acting as power generation or heat-pump devices. - Complete the development of alpha-particle semiconductors to harness energy from alpha-emitting materials and create ultra-high energy density nuclear batteries. - Complete the development of intelligent microgrid systems for the expeditionary unit. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete the development of ultra-high efficiency piezoelectric devices. ***FY 2018 OCO Plans:*** N/A					
Title: MANEUVER ***Description:*** The Maneuver Thrust Technology Area focuses on the development, demonstration, and transition of technologies that will increase the warfighting capabilities and effectiveness of current and future Marine Corps maneuver systems. This Thrust aims at capturing emerging technologies in the areas of mobility, materials, propulsion, survivability, durability, signature reduction, modularity, and unmanned systems. The emphasis is on enhancing capabilities for manned and unmanned ground platforms in support of Marine Corps expeditionary warfare objectives including: Expeditionary Force-21, Operational Maneuver from the Sea, Ship to Objective Maneuver, SeaBasing, and sustained operations ashore. ***FY 2016 Accomplishments:*** - Continued development of fuel efficiency and battlefield power systems for improved performance. - Continued survivability improvements and technologies to mitigate acceleration and traumatic brain injuries to occupants to enhance tactical mobility and survivability. - Continued advanced suspension systems development with ride height adjustment, ride quality adjustment, rollover prevention, and load equalizing systems for USMC tactical wheeled platforms to enhance tactical mobility in support of Distributed Operations. - Continued a survivability/active protection systems improvement effort to increase effectiveness of defeat (Pdefeat) of shoulder launched RPG type threats and ATGM threats on light platforms utilizing non-kinetic kill technologies.	13.435	14.576	13.598	0.000	13.598

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued efforts evaluating the current ground fleet platforms for their mobility and control capabilities as they relate to inclusion of an autonomous vehicle capability that will provide support to the dismounted Marine during Enhanced Company Operations (ECO). - Continued efforts to demonstrate integrated armor solutions that provide lighter weight armor materials with enhanced protection to vehicle occupants thereby enhancing tactical mobility and survivability. - Continued the development of autonomy technologies and system concepts that will enable unmanned ground vehicles (UGVs) to be used as autonomous logistic connector vehicles. - Continued the development of fuel saving vehicle technologies, including advanced transmission, power train, and electrical power system technologies. - Continued mobility technologies that enable improved vehicle/warfighter agility and stability. - Continued lightweight armor, material, and structural technologies that enable maneuver and survivability of small, light expeditionary platforms. - Continued survivability technologies that enable defeat of all unitary and tandem RPG and select ATGM threats, and the demonstration of survivable vehicles. - Continued the development of technologies that enable vehicle component modularity and reduce life cycle costs. - Continued development of a Combat S&T Vehicle demonstrator to enhance crew survivability and vehicle fuel efficiency. - Continued new mobility efforts for On-Board Vehicle Power to increase mobile exportable power for Diesel Electric Propulsion Concepts and a Fuels effort to investigate future fuel alternatives for internal combustion engines to include Fischer-Tropsch and coal gasification processes for use in military tactical wheeled vehicles. - Continued Maneuver Enabling Technologies such as Vehicle Stabilization to improve vehicle suspension and control technologies to stabilize the platforms themselves to improve ride quality, shoot on the move capability and human systems integration. - Continued development of a vehicle demonstrator that focuses on enhanced crew survivability. - Continued the development of autonomous perception technologies to enable operations under adverse atmospheric conditions. - Completed a Vehicle Demonstrator program to design and fabricate an Integrated Power Demonstrator platform capable of producing the power needs for mobility and survivability concept demonstrations. - Completed advanced electromagnetic armor technology development efforts.					
FY 2017 Plans: - Continue all efforts of FY 2016, less those noted as completed above.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue programs to address and enhance maneuver capability gaps in mobility such as efforts, transitioned from 6.2, aimed at the development of an autonomous vehicle capability that will provide mobility and logistics support to the dismounted Marine during Enhanced Company Operations (ECO). - Complete studies to identify technology development plans to close identified force protection capability gaps. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as completed above. - Complete development of a vehicle demonstrator that focuses on enhanced crew survivability. ***FY 2018 OCO Plans:*** N/A					
Title: EXPEDITIONARY CYBER ***Description:*** This activity supports the Cyber Advanced Technology Development program which is intended to provide freedom of maneuver and influence in the Cyber-Electronic Warfare domain while simultaneously denying the same to the adversary and protecting critical command systems. Technologies are being developed using a multi-disciplinary approach that combines RF electronics, digital signal processing, computer engineering, software engineering, machine learning and data science to support Naval Expeditionary warfighters operating with size, weight and power constrained equipment in disrupted, intermittent, low bandwidth environments (DIL). Areas of advanced technology development include urban RF mapping, RF-enabled cyber payloads, Cyber payload delivery architecture, Cyber battle damage and collateral damage assessment, anomaly detection, cognitive active authentication and full spectrum expeditionary cyber training. The increase from FY17 to FY18 is the result of realignment of resources for a more focused investment in Marine unique Expeditionary Cyber at the tactical edge to include protecting platforms, autonomous systems, sensors, and critical infrastructure. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** - Initiate a USMC Expeditionary Cyber Advanced Technology Activity addressing Cyber at the Tactical edge.	0.000	0.000	4.000	0.000	4.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate RF-enabled cyber payloads. - Initiate low SWAP distributed precision time transfer. - Initiate cognitive authentication. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	86.525	93.355	94.664	0.000	94.664

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this PE is the development of technologies to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
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COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2297: *Futures Directorate*	0.000	41.861	47.061	59.743	-	59.743	47.443	48.392	48.392	49.360	Continuing	Continuing

A. Mission Description and Budget Item Justification

As a subordinate organization under the Deputy Commandant, Combat Development and Integration (DC, CD&I), the mission of the Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) is to identify future challenges and opportunities, develop warfighting concepts, and comprehensively explore options in order to inform the combat development process to meet the challenges of the future operating environment. DC, CD&I is designated as the United States Marine Corps (USMC) Advocate for Science and Technology (S&T). MCWL's Commanding General (CG) is the DC, CD&I designated Proponent of USMC S&T and serves as the USMC Executive Agent for Marine Corps S&T. The MCWL/FD also serves as the Marine Corps' liaison to the Joint Staff for Joint Concept Development and Experimentation; thereby facilitating service-specific experiments as well as participation in joint service experimentation.

The current MCWL/FD Campaign Plan addresses how the Naval Services must reshape their capabilities in order to meet the concepts and Concepts of Operations (CONOPS) called for in the Secretary of the Navy's "Cooperative Strategy 21" and the Marine Corps' capstone "Expeditionary Force 21 (EF21)" concept, according to the objectives of the Commandant of the Marine Corps' guidance to develop the future Marine Corps Force 2025. Execution of the MCWL/FD Campaign Plan results in recommendations to Marine Corps advocates and proponents so that they may more cohesively and logically structure the future Navy and Marine Corps team. In support of the Marine Corps' role to provide an ever-ready quick strike force to protect US interests, MCWL/FD pursues concepts and new capabilities focused on the Marine Air-Ground Task Force (MAGTF). The MAGTF is the Marine Corps' doctrinal, task organized, force deployment package. It consists of four elements: the Command Element that provides overarching command and control (C2) of the entire force; the Ground Combat Element normally built around a core infantry unit with supporting armor, artillery, and other ground units; the Aviation Combat Element which provides aircraft, air defense, and other aviation functions; and the Logistics Combat Element which consists of combat service support (CSS) elements including medical, supply, and transportation. Marine Corps Force 2025 also seeks to maximize the employment of electronic, information, and cyber warfare, as well as manned/unmanned teaming, within each element of the MAGTF. MCWL/FD also examines future enhancements in training, organization, and equipment. MCWL/FD accomplishes its mission through five subordinate Divisions:

Futures Assessment Division's (FAD's) mission is to: research, examine, and describe plausible future security environments 15 to 30 years into the future. Knowledge of these future security environments will provide an estimate of possible future threats, challenges, and opportunities, to include: the rise of possible partners and adversaries, emerging disruptive technologies, and likely sources of conflict. This work is largely accomplished through research, seminar participation, and coordination with various experts in academia, the intelligence community, and think tanks.

The mission of Concepts and Plans (CAP) Division is to: examine select future security environments, emerging warfighting opportunities and challenges, and Naval warfare and joint/coalition integration and capabilities, in order to develop Marine Corps Service concepts and CONOPS to promote development of the emergent Marine Corps force. CAP is responsible for the production of formally published concepts, CONOPS, and options for future force organization and posture that describe how the Marine Corps will operate and fight.

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Wargaming Division conducts formal wargames to frame emerging warfighting concepts, establish the Joint context for the Marine Corps Force Development System, and identify opportunities for development of experimental and non-experimental capabilities.

Experiment Division conducts live force concept-based experimentation to facilitate exploration of prototype and surrogate technologies, as well as Tactics, Techniques, and Procedures (TTPs), in order to better refine equipment requirements and to identify Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) initiatives needed to produce future capabilities.

Science and Technology (S&T) Division conducts investigations and assessments to identify, modify where appropriate, and evaluate technological capabilities that support advanced warfighting concepts, and to explore the military utility of promising new commercial or government technologies in support of urgent and compelling needs. MCWL/FD investigates the relevance to EF21 capabilities and gaps of advanced technologies according to the following EF21 derived Thrust Areas: Command, Control, Communications, and Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR); Autonomy and Robotics; MAGTF Fires; Maneuver; Expeditionary Logistics (to include Expeditionary Energy); Expeditionary Medicine; Cyber and Electronic Warfare (EW); and Force Protection.

MCWL/FD investments encompass inquiries into multiple warfighting areas, including: CSS and Force Protection; MAGTF C4; MAGTF ISR; Fires, Targeting, and Maneuver; and Warfighting Excellence.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: COMBAT SERVICE SUPPORT (CSS) AND FORCE PROTECTION	6.252	10.785	18.206	0.000	18.206
Description: This activity includes MCWL/FD CSS and force protection experimentation efforts including assessment of equipment, new Tactics, Techniques, and Procedures (TTP), training programs, and proposed organizational changes associated with enhanced capabilities. Although this category covers a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity may be conducted under the Thrust Areas of Expeditionary Logistics, Expeditionary Medicine, Force Protection, or Autonomy and Robotics. The FY 2016 to FY 2017 increase in category funding is attributable to a shift in radar technology use (due to lack of technological advances as well as availability), while investigating systems that can identify, neutralize, or destroy unmanned systems. This realization led to increased costs due to exploring additional/alternative radar capabilities. In addition, increased emphasis on logistics enablers, prototype autonomous air delivery technology purchases, and expanded efforts to enable standoff detection of Improvised Explosive Devices (IEDs) caused funding to increase.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The funding increase from FY 2017 to FY 2018 is primarily attributable to initiation of the integration and experimentation with DARPA-initiated Vertical Take-Off and Landing (VTOL) developed technology for a full scale, modular multi-mission unmanned air system (UAS). ***FY 2016 Accomplishments:*** - Continued to develop and experiment with bio-sciences (medical) technologies. - Continued assessment of unmanned ground logistics delivery technologies that support infantry small unit operations. - Continued research and assessment of technologies that reduce the demand required to support the MAGTF. - Continued testing and assessment of logistics enablers in support of EF21 experimentation. - Continued assessment and experimentation with technologies that provide enhanced medical care over a distributed battlefield, to include "virtual" care and the use of autonomous systems in support of medical evacuation over ground, surface (water), or air. - Continued evaluation and assessment of emerging technologies that support energy demand reduction. - Continued investigation and assessment of logistics related emerging autonomous air delivery technologies and capabilities that further enhance current Programs of Record (PORs) and influence future planning and decision making. - Continued evaluation and experimentation with technologies that can identify, neutralize, or destroy unmanned systems (aerial, ground, or surface). - Completed a MCWL-Defense Advanced Research Projects Agency (DARPA) partnership for the development and demonstration of a MCWL centric legged robot in an effort to "Lighten the Load" of individual Marines. - Initiated research and assessment of advanced manufacturing techniques to determine military utility in expeditionary environments. - Initiated assessment and experimentation to understand the relevance of autonomy to ship to shore surface connectors. - Initiated assessments and experimentation with advanced technologies to enable standoff detection of IEDs. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. - Complete development and experimentation with bio-sciences (medical) technologies. - Complete research and assessment of technologies that reduce the demand required to support the MAGTF. - Initiate development and assessment of enhanced seabased medical capabilities in support of the MAGTF. ***FY 2018 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue all efforts of FY 2017, less those noted as complete above. - Complete evaluation and assessment of emerging technologies that support energy demand reduction. - Complete research and assessment of advanced manufacturing techniques to determine military utility in expeditionary environments. - Initiate assessments and experimentation in order to provide logistics common operational picture for commanders and logistics planners across the area of operations. - Initiate assessments and experimentation on technologies which will either mask signatures generated by MAGTF elements across the signature spectrum (seismic, aural, electronic, visual) or will enable the MAGTF to deceive adversaries as to the true friendly locations. - Initiate integration and USMC experimentation of DARPA-developed technology for a full scale, modular, VTOL multi-mission UAS platform. ***FY 2018 OCO Plans:*** N/A					
Title: FIRES, TARGETING, AND MANEUVER	4.782	3.071	6.114	0.000	6.114
Description: This activity includes Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) experimentation efforts in the areas of fires, targeting, and maneuver including assessment of equipment, new Tactics, Techniques, and Procedures (TTP), training programs, and proposed organizational changes associated with enhanced capabilities. Although this category covers a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of MAGTF Fires, Maneuver, and Autonomy and Robotics. The funding decrease from FY 2016 to FY 2017 reflects reduced levels of investment in autonomous swarming technologies and the completion of airborne and ground weaponized autonomous/semi-autonomous "man-in-the-loop" system evaluations and assessments. FY funding increase from 2017 to FY 2018 reflects expanding investigations in weaponized unmanned ground autonomous systems and initiating assessment and experimentation with munitions that enhance small tactical unit threat engagement abilities. ***FY 2016 Accomplishments:*** - Continued development and assessment of weaponized unmanned ground robotic systems.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of technologies that enhance the utility of autonomous systems. - Continued research, development, and experimentation with weapons and other ground combat systems that enhance the combat effectiveness of small units operating in the urban littorals. - Continued investigation of innovative technologies to enhance squad-level capabilities. - Continued evaluation and assessment of both airborne and ground weaponized autonomous/semi-autonomous "man-in-the-loop" systems. - Completed test and assessment of future ship to shore connectors that support EF21. - Initiated assessment and experimentation into the utility of robotic systems as platforms to support target acquisition and designation. - Initiated assessment of the expeditionary utility of autonomous swarming technologies for unmanned air and ground systems. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. - Complete evaluation and assessment of both airborne and ground weaponized autonomous/semi-autonomous "man-in-the-loop" systems. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as complete above. - Initiate assessment and experimentation with a suite of robust, responsive, and accurate munitions that will provide the small tactical unit with a capability to engage threat targets beyond engagement of current line-of-sight or indirect fire weapons in complex environments. ***FY 2018 OCO Plans:*** N/A					
Title: MARINE AIR-GROUND TASK FORCE (MAGTF) COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4) ***Description:*** This activity encompasses all MCWL/FD C4 related experimentation efforts including assessment of equipment, new Tactics, Techniques, and Procedures (TTP), training programs, and proposed organizational changes associated with enhanced C4 capabilities. Although this category covers a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of C4ISR and Cyber/EW.	10.020	9.770	10.525	0.000	10.525

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The funding increase from FY 2017 to FY 2018 reflects increased efforts in Tactical Cyber/EW. ***FY 2016 Accomplishments:*** - Continued development and assessment of a MAGTF network management system. - Continued a follow-on effort to test and evaluate an integrated C2 application in support of EF21 experimentation. - Continued development and assessment of systems that permit Unmanned Aerial System (UAS) operations in a global positioning system (GPS) denied environment. - Continued development and assessment of a configurable C2 suite that enhances operations from aviation platforms in support of EF21 experimentation. - Continued investigations and assessment of technologies that support C2 enablers for shore deployed MAGTF elements that is platform agnostic and capable of deployment from the sea, air, or ground. - Continued evaluation and experimentation with emerging technologies that support future maritime C2 capabilities/EF21. - Completed development and assessment of a configurable C2 suite that enables operations from alternate seabased platforms in support of EF21 experimentation. - Completed development and assessment of a configurable C2 suite that enhances operations from L-Class shipping in support of EF21 experimentation. - Completed development and assessment of technologies that support a maritime Fly-In Command Element (FICE) capable of operating from the sea-base during the conduct of immediate crisis response operations. - Initiated assessment and experimentation with integration and interoperability of software applications to increase the situational awareness, lethality, and survivability of distributed tactical ground formations. ***FY 2017 Plans:*** - Continue all efforts of FY 2016, less those noted as complete above. - Complete development and assessment of a MAGTF network management system. - Initiate exploration, development, and experimentation of cyber/EW capabilities at the tactical level, to enable tactical operators to sense, visualize, and exploit the cyber/EW environment. - Initiate development and experimentation that enable seamless operations in a technology denied environment. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as complete above.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete development and assessment of a configurable C2 suite that enhances operations from aviation platforms in support of EF21 experimentation. - Initiate development and experimentation with new technologies for radio frequency (RF) signature reduction. - Initiate development and experimentation with enhanced/consolidated, MAGTF insert-able, and seamless over-the-horizon (OTH), on-the-move (OTM), and at-the-halt (ATH) communications capabilities which will support missions without pre-planned coverage areas. - Initiate development and experimentation with mission management capabilities (to be used by mounted and dismounted ground forces) that include sensor processing and exploitation, multi-sensor integration and control, multi-platform coordination, and situational awareness. ***FY 2018 OCO Plans:*** N/A					
Title: MARINE AIR-GROUND TASK FORCE (MAGTF) INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) ***Description:*** This activity includes MCWL/FD ISR related experimentation efforts including assessment of equipment, new Tactics, Techniques, and Procedures (TTP), training programs, and proposed organizational changes associated with enhanced ISR capabilities. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of C4ISR and Autonomy and Robotics. The decrease in funding from FY 2016 to FY 2017 reflects the completion of development and assessment of enhanced Unmanned Aerial System (UAS) sensor packages. The FY 2017 to FY 2018 increase is due to investigating, developing and/or assessing technologies that: reduce tactical surprise, automate UAS management, improve ground autonomy, and address employment concepts for information operations. ***FY 2016 Accomplishments:*** - Continued development and assessment of seabased and landing force ISR capabilities that enable EF21 experimentation. - Continued development, integration, and assessment of technologies to fuse multiple sensor payloads into a single user interface to enable utility for tactical operators.	5.619	4.048	6.414	0.000	6.414

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development and assessment of enhanced UAS sensor packages. - Continued examination and assessment of technologies that support future employment of UAS operations from seabased platforms. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. - Complete development and assessment of enhanced UAS sensor packages. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017, less those noted as complete above. - Initiate development and assessment of technologies that reduce tactical surprise by providing a self/air deployable UAS capable of dashing ahead of MV-22 aircraft to conduct final reconnaissance of objective area to update threat situation in route to objective area. - Initiate development and assessment of an expeditionary drone deployment system (in order to automate UAS ground handling, control, launch, and recovery) to enable mission-level tasking and untrained operations of a fleet of small UAS. - Initiate investigations on employment concepts for information operations at the tactical level, including an assessment of technological developmental requirements. ***FY 2018 OCO Plans:*** N/A					
Title: MARINE CORPS WARFIGHTING LABORATORY / FUTURES DIRECTORATE (MCWL/FD) OPERATIONS (SUPPORT) ***Description:*** MCWL/FD Operations (Support) efforts include overall MCWL/FD experimentation doctrine, planning, analysis, data collection, as well as technology transition tracking efforts. Programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. The FY 2016 to FY 2017 as well as the FY 2017 to FY 2018 increases are attributable to increased levels of technical/engineering support needed to facilitate experimentation objectives. ***FY 2016 Accomplishments:*** - Continued to synthesize results and lessons learned into proposed DOTMLPF recommendations for the Marine Corps. - Continued to provide technical, strategic, and managerial support to Marine Corps experimentation.	10.782	11.682	12.418	0.000	12.418

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Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued to provide overall analysis and reporting of experimentation efforts, analytical assistance during experiment design, and maintenance of an ad-hoc analysis capability. - Continued deliberate broad-based commercial technology forecasting in support of experimentation long-range planning and combat development. - Continued technical, strategic, and managerial support for operations with advanced technology utilizing autonomy, robotics, and cyber capabilities. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017. ***FY 2018 OCO Plans:*** N/A					
Title: WARFIGHTING EXCELLENCE	4.406	7.705	6.066	0.000	6.066
Description: This activity includes Marine Corps Warfighting Laboraroty / Futures Directorate (MCWL/FD) efforts in the development and assessment of joint and service warfighting concepts, joint and service missions, analysis of emerging threats and opportunities, and joint capability experimentation. It also includes MCWL/FD service experimentation in areas that impact multiple warfighting functions. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near-real-time operational impact. The FY 2016 to FY 2017 increase in category funding is attributable to increased wargaming and involvement/participation in joint arena technology demonstration programs with an ultimate aim to rapidly field needed capabilities by capitalizing on emergent technologies and innovational operational concepts. The FY 2017 to FY 2018 decrease in category funding is due to: reducing funds provided for joint programs in order to focus on assessing FY 2017 investment outcomes/progress as well as the completion of experimentation focused modeling and simulation development/assessments. ***FY 2016 Accomplishments:*** - Continued executive agent responsibilities for the Marine Corps Title Ten (X) Wargame, Expeditionary Warrior, as well as the Joint and other service Title X programs, such as the United States Army's Unified Quest, the Air					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Force's Unified Engagement and Futures wargame, and the Navy Global wargame. Title X war games address future capabilities in the context of Title X readiness responsibilities. - Continued management and oversight of non-Title X Wargaming, including the highly visible Office of the Secretary of Defense Net Assessment Transformation War Game series and the Special Operations Command wargaming series. - Continued to support the core Center for Emerging Threats and Opportunities (CETO) mission to: provide broad-based technical and analytical support for Marine Corps combat development and experimentation programs at the component, Service, and Joint levels. This support includes the full spectrum of combat development-related missions and tasks to include the assessment of plausible future security environments and the identification of future threats, adversaries, opportunities, technologies, strategic settings, and associated geographic, environmental, economic, and demographic conditions in order to inform the development of innovative warfighting concepts, CONOPS, and capabilities across the DOTMLPF spectrum. Serve as a catalyst to stimulate thought and debate on issues of importance to the Marine Corps. - Continued funding contributions to Joint Concept Technology Demonstrations (JCTDs) and Emerging Capability Technology Demonstrations (ECTDs) (formerly known as Advanced Concept Technology Demonstrations (ACTDs)). Both JCTDs and ECTDs are intended to rapidly field needed capabilities by using emergent mature technologies matched with innovative operational concepts. - Continued development and assessment of modeling and simulation hardware, software, and training capabilities that support planning/experimentation processes. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017. - Complete development and assessment of modeling and simulation hardware, software, and training capabilities that support planning/experimentation processes. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	41.861	47.061	59.743	0.000	59.743

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this PE is the development, demonstration, and assessment of technologies that represent capabilities to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare in the future. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603651M *I JT Non-Lethal Wpns Tech Dev*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	12.374	13.117	13.448	-	13.448	13.387	13.387	13.387	13.655	Continuing	Continuing
3022: *Joint Non Lethal Weapons*	0.000	12.374	13.117	13.448	-	13.448	13.387	13.387	13.387	13.655	Continuing	Continuing

A. Mission Description and Budget Item Justification

The DOD Non-Lethal Weapons (NLW) Program was established by the Office of the Secretary of Defense, which designated the Commandant of the Marine Corps (CMC) as the DoD NLW Executive Agent (EA). The EA exercises centralized responsibility for joint research and development of non-lethal weapons and technology through the Joint Non-Lethal Weapons Program (JNLWP). The Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) provides direct oversight of the JNLWP.

The efforts described in this Program Element (PE) reflect science and technology (S&T) investment decisions provided by the Joint Non-Lethal Weapons (NLW) Integrated Product Team, a multi-service flag level corporate board that provides executive oversight and management for the JNLWP for the CMC. This direction is based on the needs and capabilities of the Services, the Special Operations Command, and the Coast Guard, as identified in the DoD's Non-Lethal Weapons Joint Capabilities Based Assessment Document. This coordinated joint S&T development approach addresses mutual capability gaps and assures the best non-lethal technologies, capabilities and equipment are provided to the operating forces while eliminating duplicative service S&T investment. These advanced technology development initiatives feed non-lethal capabilities which directly support the three pillars of the 2014 Quadrennial Defense Review and comprise a fundamental part of DoD's security cooperation efforts to build partner capacity. The resulting capabilities will facilitate a fully integrated non-lethal competency as a complement to lethal firepower, providing force application options for short-of-lethal scenarios.

This program funds Advanced Technology Development of next-generation non-lethal capabilities and includes performing analysis, technology development efforts, and modeling and simulation necessary to ensure optimum weaponization and use of these capabilities. Investment areas include research and development of next-generation NLWs such as: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-materiel missions; non-lethal counter-personnel technologies (acoustic, optical, and human electro-muscular disruption technologies), and advanced non-lethal materials (including materials for vehicle/vessel stopping and counter-facility applications). Next-generation non-lethal systems focus on long-range localized non-lethal effects to identified threat individuals (or groups of individuals) and/or their threat weapons systems operating in complicated environments such as urban areas, crowds, buildings, vehicles, vessels, and also in close proximity to high-value civilian facilities.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603651M *I JT Non-Lethal Wpns Tech Dev*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	12.745	13.117	13.448	-	13.448
Current President's Budget	12.374	13.117	13.448	-	13.448
Total Adjustments	-0.371	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.371	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603651M / *JT Non-Lethal Wpns Tech Dev*	Project (Number/Name) 3022 / *Joint Non Lethal Weapons*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
3022: *Joint Non Lethal Weapons*	0.000	12.374	13.117	13.448	-	13.448	13.387	13.387	13.387	13.655	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds the research and development of next-generation NLWs and includes performing analysis, technical development efforts, and modeling and simulation necessary to ensure optimum weaponization and use of these NLWs. Investment areas include research and development of next-generation NLWs such as: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-materiel missions; non-lethal counter-personnel technologies (acoustic, optical, and human electro-muscular disruption technologies), and advanced non-lethal materiels (including materiels for vehicle/vessel stopping and counter-facility applications). Next-generation NLW systems focus on long-range localized NL effects to identified threat individuals (or groups of individuals) and/or their threat weapons systems operating in complicated environments such as urban areas, crowds, buildings, vehicles, vessels, and also in close proximity to high-value civilian facilities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: JOINT NON-LETHAL WEAPONS	12.374	13.117	13.448	0.000	13.448
FY 2016 Accomplishments: - Continued effort to assess the general utility, effect, and effectiveness of technologies for incapacitating personnel, clearing facilities, stopping vehicles and vessels, and denying enemy access to protected areas. - Continued prototype development and transition to higher levels of technology development of advanced payloads for candidate technological capabilities with applications relevant to emerging capability gaps. - Continued transition to higher levels of technology development and demonstrate the most promising directed energy technologies under consideration for counter-personnel and counter-materiel applications. - Continued non-lethal effects characterization through modeling and effects testing for joint advanced technology development using Human Effects Modeling Analysis Program (HEMAP). - Continued evaluation of alternative non-lethal prototype technologies offering operational utility and transition best candidates to higher levels of technology development and acquisition. - Continued advanced prototype development and demonstration of a smaller, lighter active denial technology demonstrator based on the most promising and mature 95 GHz source technology. - Continued prototype development, demonstration and transition to higher levels of technology development of the most promising candidate technologies addressing the extended range/duration incapacitation capability gap. - Continued modular prototyping of High Power Microwave (HPM) component hardware meeting development objectives for subsequent integration into an HPM-capable system configuration.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603651M / *JT Non-Lethal Wpns Tech Dev*	**Project (Number/Name)** 3022 / *Joint Non Lethal Weapons*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Completed transition to higher levels of development and demonstration for the most promising candidate technologies employing multisensory stimuli. - Completed incorporation of suitable sensors capable of measuring NL stimuli into surrogate test models as part of the HEMAP. ***FY 2017 Plans:*** - Continue all efforts from 2016, except those noted as completed. - Initiate development of technologies to deliver emerging novel counter-materiel and counter-personnel payloads to target while minimizing risk to the operator. - Initiate development of a laboratory/benchtop High-Power Radio-Frequency (HPRF) directed energy system to validate short pulse counter-materiel effects. Refine, integrate and demonstrate breadboard system. - Complete advanced prototype development and demonstration of a smaller, lighter active denial technology demonstrator based on the most promising and mature 95 GHz source technology. ***FY 2018 Base Plans:*** - Continue all efforts from 2017, except those noted as completed. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	12.374	13.117	13.448	0.000	13.448

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this Program Element is the development of technologies that lead to the next-generation of Non-Lethal Weapons which address identified and prioritized joint NLW capability gaps. The program consists of a collection of projects for the development and evaluation of feasibility demonstration models. Individual project metrics reflect the technical goals of each specific project. Typical metrics include both the effectiveness of the technology, human effects and effectiveness, mitigation of high priority joint NLW capability gaps, and potential for compliance with policy and legislation. Overarching considerations include the advancement of

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603651M / *JT Non-Lethal Wpns Tech Dev*	**Project (Number/Name)** 3022 / *Joint Non Lethal Weapons*

related Technology Readiness Levels and Human Effects Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603673N *I (U)Future Naval Capabilities Advanced Tech Dev*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	251.173	249.092	231.772	-	231.772	233.894	231.250	250.677	270.614	Continuing	Continuing
3346: *Future Naval Capabilities Adv Tech Dev*	0.000	244.414	249.092	231.772	-	231.772	233.894	231.250	250.677	270.614	Continuing	Continuing
9999: *Congressional Adds*	0.000	6.759	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.759

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Future Naval Capabilities (FNC) Program. The FNC Program represents the requirements-driven, delivery-oriented portion of the Navy's Science and Technology (S&T) portfolio. FNC investments respond to Naval S&T Gaps that are identified by the Navy and Marine Corps after receiving input from Naval Research Enterprise (NRE) stakeholders. The Enabling Capabilities (ECs) and associated technology product investments of the FNC Program are competitively selected by a 3-star Technology Oversight Group (TOG), chartered by the S&T Corporate Board and representing the requirements, acquisition, research and fleet/forces communities of the Navy and the Marine Corps.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	265.562	249.092	259.009	-	259.009
Current President's Budget	251.173	249.092	231.772	-	231.772
Total Adjustments	-14.389	0.000	-27.237	-	-27.237
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-9.029	0.000			
• SBIR/STTR Transfer	-5.360	0.000			
• Program Adjustments	0.000	0.000	-27.237	-	-27.237

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *ASW Research Prog - Cong*	6.759	0.000
Congressional Add Subtotals for Project: 9999	6.759	0.000
Congressional Add Totals for all Projects	6.759	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603673N *I (U)Future Naval Capabilities Advanced Tech Dev*

Change Summary Explanation

The FY 2017 funding request was reduced by -$5.0 million as required for the Department of the Navy to comply with the Bipartisan Budget Act of 2015.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	Project (Number/Name) 3346 / *Future Naval Capabilities Adv Tech Dev*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
3346: *Future Naval Capabilities Adv Tech Dev*	0.000	244.414	249.092	231.772	-	231.772	233.894	231.250	250.677	270.614	Continuing	Continuing

A. Mission Description and Budget Item Justification

FNC investments are typically 3-5 years in duration. They provide a continuance of basic research by maturing technologies from a Technology Readiness Level (TRL) of 3 or 4 to a TRL of 6. All FNC products require BA2 and BA3 funded technology development, which is coordinated to ensure tangible technology products are delivered upon completion of each investment. Each year the TOG refreshes the FNC Program by approving new ECs and technology products as older ones get delivered. After transition to an acquisition program, FNC products are further engineered, integrated and ultimately, delivered to the warfighter. The development and delivery of each FNC product is guided by a Technology Transition Agreement (TTA) that is signed by the requirements and acquisition sponsors, as well as the S&T developer.

This project supports the naval pillars of Capable Manpower, Enterprise and Platform Enablers, Expeditionary Maneuver Warfare, Force Health Protection, Forcenet, Power and Energy, Sea Basing, Sea Shield and Sea Strike. Each of these pillars is listed as a separate R-2 Activity. Under each R-2 Activity, the BA 6.3 accomplishments and plans for every Enabling Capability (EC) and Technology Product in the FNC Program are listed. ECs are composed of one or more interrelated technology products, so for clarity, each product is shown under its EC.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: CAPABLE MANPOWER (CMP)	17.441	19.195	19.541	0.000	19.541
Description: This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Capable Manpower (CMP) FNC pillar. The CMP Pillar develops deliverable technologies that provide new capabilities in manpower and personnel management, training and education, and human-systems integration for more intuitive systems.					
FY 2016 Accomplishments: EC: CMP-FY12-01 LIVE, VIRTUAL, & CONSTRUCTIVE TRAINING FIDELITY - Complete Cognitive Fidelity Synthetic Environment - Design and develop virtual simulations that elicit the appropriate perceptual-cognitive responses for Naval aviation training. - Complete Tactics & Speech Capable Semi-Automated Forces - Demonstrate software that automatically generates doctrinally accurate semi-autonomous forces that are adaptive to training scenario events. - Complete Virtual-Constructive Representations on Live Avionics Displays - Test, evaluate, and refine the Live, Virtual, & Constructive (LVC) symbology used during experimentation and validation efforts.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Continue Manpower Planning and Optimization Toolset - Demonstrate software that assesses the risks and capabilities of varying levels of manpower authorizations to operate a specific platform design during various mission scenarios. - Continue Platform Design and Acquisition Toolset - Demonstrate software that assesses the trade space and cost commitments of different platform designs and manning compliments. EC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT) - Continue Dynamic, Adaptive & Modular Training for UAS - Design knowledge structures for integration with DoN simulation and training systems. - Continue Selection for UAS Personnel (SUPer) - Construct unmanned aircraft operator selection and classification test batteries, including underlying data collection instruments within the DoN's APEX framework. - Continue UAS Control Station Human Machine Interface - Create Common Control Station information display design specifications that focus on supervisory control and the reduction of the information demands placed on unmanned aircraft system operators. EC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Continue Decision Making-Learning Management System (DM-LMS) - Define existing Marine Corps measures and standards of decision making and instructional method guidelines, and develop software products to plan, assess, and track decision making skill development. - Continue Digital Integrated Representation of Tactical Environment (DIRTE) - Define existing Marine Corps CONOPS for classroom and sustainment training and develop rapid terrain modeling and sketchpad software products that enable small unit leaders and instructors to create effective decision making environments and scenarios. - Continue Simulation Tailored Training and Assessment (ST2A) - Define existing Marine Corps situated tutor techniques and unobtrusive monitoring techniques, and develop software and hardware prototypes to execute decision making programs of instruction and scenarios in simulation. EC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS TRAINING & EXPERIMENTATION (EDUCAT2E)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) - Develop threat response software models to support an objective, metrics-driven training and experimentation capability for Fast Attack Craft and Mine Warfare threats. EC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Initiate Operational Planning Tool - Demonstrate software to facilitate the planning cycle structure used by Navy command and control planners to prepare mission plans that range from the Maritime Operations Centers down to maritime tactical units.					
FY 2017 Plans: EC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Continue Manpower Planning and Optimization Toolset - Develop software that produces a feasible set of shipboard event timelines, workload packages, and skills for each billet created for a given ship and system design. - Complete Platform Design and Acquisition Toolset - Demonstrate software to simulate the design and manpower interactions that are used to determine the trade spaces and cost commitments required for a given platform design and manning compliment. EC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT) - Continue UAS Control Station Human Machine Interface - Deliver Human Machine Interface Prototype Software for supervisory control of unmanned systems to the submarine combat system. - Complete Selection for UAS Personnel (SUPer) - Develop and demonstrate unmanned aircraft operator selection and classification test batteries. - Complete Dynamic, Adaptive & Modular Training for UAS - Develop and demonstrate automated scenarios and clutter entity behaviors in the Navy's common training system technology for the Next Generation Threat System. EC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Continue Digital Integrated Representation of Tactical Environment (DIRTE) - Define Enterprise level Application Programming Interface (API) requirements to create Virtual Battlespace 2 (VBS2) terrain from					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
government supplied source data (e.g., National Geospatial-Intelligence Agency products such as Digital Terrain Elevation Data and Digital Feature Analysis Data). - Continue Simulation Tailored Training and Assessment (ST2A) - Develop software and hardware prototypes to execute decision making programs of instructional scenarios in simulation. - Continue Decision Making-Learning Management System (DM-LMS) - Develop a Marine Corps Training Information Management System (MCTIMS) software prototype to provide repository and trend analysis of performance data to inform training readiness assessments, including the performance and development of individual Marines, small unit leaders, and small units over time. EC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS TRAINING & EXPERIMENTATION (EDUCAT2E) - Continue Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) - Demonstrate simulated Electromagnetic Environmental Effects on Fleet training and operational systems in a networked Live, Virtual, and Constructive environment in a distributed scenario-driven Fleet Synthetic Training event. EC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Continue Operational Planning Tool - Develop software to assist Carrier Strike Group staffs that support comprehensive/collaborative planning through the use of decision support services, analytic tools, and common displays that assist planners during the creation of navigation and tactical plans. EC: CMP-FY17-02 FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE) - Initiate Future Integrated Training Environment (FITE) - Develop technologies and techniques to integrate Marine Corps simulations to support Live, Virtual, and Constructive training events. ***FY 2018 Base Plans:*** FNC: CMP-FY13-02 SIMULATION TOOLSET FOR ANALYSIS OF MISSION, PERSONNEL AND SYSTEMS (STAMPS) - Complete Manpower Planning and Optimization Toolset - Demonstrate the newly developed manpower planning and optimization functional enhancements targeted for transition. FNC: CMP-FY14-02 UNMANNED AERIAL SYSTEMS INTERFACE, SELECTION AND TRAINING TECHNOLOGIES (U-ASISTT)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete UAS Control Station Human Machine Interface - Integrate human machine interface and vehicle controller software into the Advanced Processor Build (APB) -17 software update for the AN/BYG-1 combat control system. FNC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM) - Complete Decision Making-Learning Management System (DM-LMS) - Assess the reliability and validity of DM-LMS design measures. - Complete Digital Integrated Representation of Tactical Environment (DIRTE) - Test and demonstrate the Graphical User Interface (GUI) to assess the ease of use and ability to modify the terrain and associated features. - Complete Simulation Tailored Training and Assessment (ST2A) - Test and evaluate the full ADSUDM concept using the integrated training simulation demonstration prototype. FNC: CMP-FY15-02 ENVIRONMENT DESIGNED TO UNDERTAKE COUNTER A2AD TACTICS TRAINING & EXPERIMENTATION (EDUCAT2E) - Complete Environment Designed to Undertake Counter A2AD Tactics, Training & Experimentation (EDUCAT2E) - Conduct a final demonstration and transition the newly developed, denied-and-degraded effects technology to platform sponsors, the training community, and combat system developers. FNC: CMP-FY16-01 OPERATIONAL PLANNING TOOL - Continue Operational Planning Tool - Develop new software tools that support comprehensive and collaborative planning through the use of decision support services, analytic tools, and common displays. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-01 under a new Information Warfare R-2 Activity) FNC: CMP-FY17-01 MANPOWER, PERSONNEL & TRAINING STRATEGIC PLANNING APPLICATION - Initiate Manpower, Personnel & Training Planning Application - For this FNC, delayed one year to start in FY18, develop decision support software to capture key interconnections, time delays and feedbacks between Manpower, Personnel, and Training stakeholders that serve as a common set of assumptions and boundaries for decision analyses. FNC: CMP-FY17-02 FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Future Integrated Training Environment (FITE) - Develop synthetic environment language to communicate changes during run-time, and implement changes within the simulations. FNC: CMP-FY18-01 LEARNING CONTINUUM AND PERFORMANCE AID (LCAPA) - Initiate Learning Continuum and Performance Aid (LCaPA) - Commence development of a federated software system to manage an individualized learning continuum through on-the-job and other training events that includes career path guidance and performance tracking. FNC: CMP-FY18-02 MANNED AND UNMANNED COMMON PLANNING PICTURE - Initiate Manned and Unmanned Common Planning Picture - Commence development of software to enable a sailor to plan and brief manned (navigation, own ship, etc.) and unmanned (UUV and UAV) events simultaneously as an integrated planning tool that communicates the commander's intent. (In FY19, this FNC Product will be realigned within this PE to UW-FY18-01 under a new Undersea Warfare R-2 Activity) FNC: CMP-FY19-03 Fleet Training Technologies (FleeT2) - Initiate FleeT2 - Commence development of adaptive, dynamic tools to capture and assess mission performance of warfare teams and operators to support high-velocity and ready relevant learning of representational techniques, model dynamics, and high computational tractability. (In FY19, this FNC Product will be realigned within this PE to SW-FY19-04 under a new Surface Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: ENTERPRISE AND PLATFORM ENABLERS (EPE) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Enterprise and Platform Enablers (EPE) FNC pillar. The EPE Pillar develops cross-cutting, deliverable technologies that provide new capabilities for naval service platforms that lower acquisition, operations and maintenance costs, improve system safety and availability, and improve platform survivability. The FY 2016 to FY 2017 decrease was due primarily to the completion of EPE-FY10-01, EPE-FY12-01 and EPE-FY12-02, and the planned ramp-down of EPE-FY09-07 and EPE-FY11-01.	20.482	19.178	14.559	0.000	14.559

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
The FY 2017 to FY 2018 decrease was due primarily to the completion of EPE-FY09-07 Advanced Material Propeller, EPE-FY11-01 Integrated Thermal Management System Design, and the ramp-down in the planned 6.3 effort for EPE-FY15-03 New Material(s) Development & Lab Characterization, which just started conducting experiments to fully characterize medium-scale material concepts. ***FY 2016 Accomplishments:*** EC: EPE-FY09-07 AFFORDABLE SUBMARINE PROPULSION AND CONTROL ACTUATION - Continue Advanced Material Propeller - Develop Full Scale Test Plan for the Collins Class Submarine. EC: EPE-FY10-01: ADVANCED SHIPBOARD WATER DESALINATION - Continue Advanced Navy Reverse Osmosis System - 100K GPD - Demonstrate and test a 100K Gallons Per Day (GPD) robust reverse osmosis based water purification system on ship platforms. - Complete Advanced Navy Reverse Osmosis System - 4K GPD - Demonstrate and test a 4,000 Gallons Per Day (GPD) robust reverse osmosis based water purification system. EC: EPE-FY11-01 FLIGHT DECK THERMAL MANAGEMENT - Continue Integrated Thermal Management System Design - Finalize testing of a scale model and begin integrating the panels to a ship deck for the final demonstration. EC: EPE-FY12-01 CORROSION MITIGATION TECHNOLOGIES - Complete Corrosion Resistant Surface Treatment - Deliver impellers treated with Corrosion Resistant Surface Treatment to PMS-505 for installation on LCS. - Complete Sprayable Acoustic Damping Systems - Demonstrate and integrate spray applied damping systems for improved structural vibration control, total ownership cost reduction, improved platform performance, and reduced detectability. EC: EPE-FY12-02 INTEGRATED HYBRID STRUCTURAL MANAGEMENT SYSTEM (IHSMS) - Complete IHSMS Fleet Structural Health Management Decision Tool - Integrate structural health monitoring system into demonstration article, demonstrate structural health monitoring rotor hot-spot sensors and integration technologies, and evaluate system performance. EC: EPE-FY13-01 TOWED ARRAY SYSTEM RELIABILITY IMPROVEMENT					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Tools for Predicting Array Operational Loading & Distribution - Develop a design for a highly instrumented towed array to be used in validating the predictive model of the forces operating on a towed array. EC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - Continue Aluminum Alloy Corrosion Mitigation Technologies - Conduct test and evaluation of prototype surface treatment and repair tools to enable aluminum alloy sensitization repair/desensitization technologies. - Continue Aluminum Alloy Corrosion Prediction Tool - Integrate a detection tool with sensitization prediction software as a singular tool with both detection and predictive capabilities to provide the time to repair aluminum ship structures. EC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Demonstrate, test, and down select advanced coating and alloy combinations that are suitable for higher temperature capable gas turbine operation. EC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Develop new test methods for materials being developed under the program. ***FY 2017 Plans:*** EC: EPE-FY09-07 AFFORDABLE SUBMARINE PROPULSION AND CONTROL ACTUATION - Complete Advanced Material Propeller - Conduct Full Scale Testing on a Collins Class Submarine. EC: EPE-FY10-01: ADVANCED SHIPBOARD WATER DESALINATION - Complete Advanced Navy Reverse Osmosis System - 100K GPD - Complete final testing of a 100K Gallons Per Day (GPD) robust reverse osmosis based water purification system on a ship platforms that was delayed due to reliable issues that were subsequently corrected. EC: EPE-FY11-01 FLIGHT DECK THERMAL MANAGEMENT - Complete Integrated Thermal Management System Design - Demonstrate feasibility of flight deck thermal management system during at-sea test.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: EPE-FY13-01 TOWED ARRAY SYSTEM RELIABILITY IMPROVEMENT - Continue Tools for Predicting Array Operational Loading & Distribution - Fabricate and use the previously designed highly instrumented towed array to validate the predictive model of the forces operating on a towed array. EC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - Continue Aluminum Alloy Corrosion Mitigation Technologies - Assess the effectiveness of the developed surface treatment and repair tools for desensitizing and repairing sensitized aluminum. - Continue Aluminum Alloy Corrosion Prediction Tool - Integrate the Degree of Sensitization (DoS) prediction algorithm software into the DoS detection tool. EC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Demonstrate, test, and down-select advanced coatings and alloy combinations that are suitable for higher temperature marine gas turbine engine service in the marine environment. EC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Construct new test methods for the materials being developed. EC: EPE-FY16-01 ADVANCED TOPCOAT SYSTEM (ATS) - Initiate Advanced Topcoat Systems for Air Vehicle (ATS-AV) - Perform initial laboratory verification and qualification studies on modified primer and topcoat chemistries, including chemical analysis and material interaction compatibility verification. FNC: EPE-FY19-04 Signature Management System (SMS) - Initiate SMS - Conduct advanced technology development for submarine applications.					
FY 2018 Base Plans: FNC: EPE-FY13-01 TOWED ARRAY SYSTEM RELIABILITY IMPROVEMENT - Complete Tools for Predicting Array Operational Loading & Distribution - Conduct at-sea testing of an instrumented towed array on a Virginia Class submarine and continue validation efforts on the numerical tool.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - Continue Aluminum Alloy Corrosion Mitigation Technologies - Demonstrate aluminum coating effectiveness to minimize Degree of Sensitization (DoS) and develop aluminum DoS repair tools to mitigate corrosion damage. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-01 under a new Surface Warfare R-2 Activity) - Complete Aluminum Alloy Corrosion Prediction Tool - Demonstrate integration of Degree of Sensitization (DoS) detection algorithms with the DoS detection tool and conduct testing of the integrated capability. FNC: EPE-FY15-02 GAS TURBINE UPGRADES FOR REDUCED TOTAL OWNERSHIP COST (TOC) AND IMPROVED SHIP IMPACT - Continue Shipboard Gas Turbine Marinization Package for Higher Temperature, Higher Pressure Operation - Conduct OEM qualification testing for environmental and mechanical properties, and ease of fabrication for engine components for a planned demonstration test. (In FY19, this FNC Product will be realigned within this PE to SW-FY15-01 under a new Surface Warfare R-2 Activity) FNC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Design and carry out experiments which fully characterize medium-scale material concepts. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-01 under a new Undersea Warfare R-2 Activity) FNC: EPE-FY16-01 ADVANCED TOPCOAT SYSTEM (ATS) - Continue Advanced Topcoat Systems for Air Vehicle (ATS-AV) - Perform initial laboratory verification and qualification studies on modified primer and topcoat chemistries, including chemical analysis and material-interaction compatibility verification. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-01 under a new Air Warfare R-2 Activity) FNC: EPE-FY19-04 Signature Management System (SMS) - Continue SMS - Continue developing advanced signature management technology for submarine applications. (In FY19, this FNC Product will be realigned within this PE to UW-FY19-01 under a new Undersea Warfare R-2 Activity) ***FY 2018 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: EXPEDITIONARY MANEUVER WARFARE (EMW)	9.824	3.060	0.000	0.000	0.000
Description: This R-2 Activity contains the Navy funded Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Expeditionary Maneuver Warfare (EMW) FNC Pillar. The EMW Pillar develops deliverable technologies that provide new capabilities in expeditionary maneuver warfare, including naval ground forces, with special emphasis on regular and irregular warfare in urban environments and combating terrorism. The FY 2016 to FY 2017 decrease was due to the planned ramp down of EMW-FY12-02 and the continuation of EMW-FY12-03, EMW-FY14-01 and EMW-FY16-01 in PE 0603640M Marine Corps Advanced Technology Demonstration. The FY 2017 to FY 2018 decrease was due primarily to the completion and transition to acquisition of EMW-FY12-02 Future Joint Counter Radio-Controlled IED Electronic Warfare (JCREW) and the continuation of EMW-FY17-01 High Reliability DPICM Replacement (HRDR) in PE 0603640M Marine Corps Advanced Technology Demonstration which was funded in this PE in FY17. ***FY 2016 Accomplishments:*** EC: EMW-FY12-02 FUTURE JOINT COUNTER RADIO-CONTROLLED IED ELECTRONIC WARFARE (JCREW) - Continue Distributed Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (D-JCREW) - Using realistic scenarios, demonstrate tactical-level distributed jamming on multiple ground-based Electronic Warfare systems. - Continue Integrated Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (I-JCREW) - Employing realistic scenarios, demonstrate the simultaneous reception and transmission of Electronic Warfare and blue-force communication waveforms. EC: EMW-FY12-03 WIDE AREA SURGICAL AND PERSISTENT SURVEILLANCE (WASPS) CAPABILITIES FOR TIER 2/3 UAVs - Complete Tactical Nighttime Wide Area Surveillance, initiated in PE 0603640M - Conduct final demonstration and complete transition.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: EMW-FY13-01 AZIMUTH AND INERTIAL MICRO-ELECTRO-MECHANICAL SYSTEM (MEMS) NAVIGATION SYSTEM - Complete Micro-Electro-Mechanical (MEMS) Inertial Navigation System - Test and demonstrate a full Navigation System for hand-held targeting systems. EC: EMW-FY14-01 SPECTRAL AND RECONNAISSANCE IMAGERY FOR TACTICAL EXPLOITATION (SPRITE) - Complete Automated Processing for Spectral Exploitation and Dissemination (APSED) - Demonstrate an Electro-Optical (EO) and Hyper-Spectral Imagery (HSI) Image Processing architecture that includes EO to HSI cross-correlation and fusion, image archiving and retrieval, and exploitation product generation. - Complete Compact Wide Area Reconnaissance and Spectral Sensor (CWARSS) - Demonstrate parts of the baseline design for a multi-model wide area sensor compatible with a small space, weight and power baseline. EC: EMW-FY16-01 DENSIFIED PROPELLANT FIRE FROM ENCLOSURE - CONFINED SPACE (FFE/CS) PROPULSION TECHNOLOGIES - Initiate Densified Propellant Fire From Enclosure - Confined Space (FFE/CS) Propulsion Technologies - Integrate rocket motor igniters with micro-electromechanical system ignition safety devices and multi-stage igniter plug designs to achieve warhead launch parameters.					
FY 2017 Plans: EC: EMW-FY12-02 FUTURE JOINT COUNTER RADIO-CONTROLLED IED ELECTRONIC WARFARE (JCREW) - Complete Distributed Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (D-JCREW) - Demonstrate tactical-level distributed jamming on multiple ground-based Electronic Warfare (EW) systems using realistic scenarios. - Complete Integrated Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (I-JCREW) - Demonstrate the simultaneous reception and transmission of Electronic Warfare (EW) and blue-force communication waveforms using realistic scenarios. EC: EMW-FY16-01 DENSIFIED PROPELLANT FIRE FROM ENCLOSURE - CONFINED SPACE (FFE/CS) PROPULSION TECHNOLOGIES - Continued in PE 0603640M Marine Corps Advanced Technology Demonstration					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT (HRDR) - Initiate High Reliability DPICM Replacement - Demonstrate with the 155mm M777A2 gun launch through modeling and simulation that High Reliability Dual-purpose Improved Conventional Munitions hardware will survive setback and gun balloting forces in order to activate the on-board power supply and initialize the arming sequence. ***FY 2018 Base Plans:*** FNC: EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT (HRDR) - Continued High Reliability DPICM Replacement in PE 0603640M. ***FY 2018 OCO Plans:*** N/A					
Title: FORCE HEALTH PROTECTION (FHP) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Force Health Protection (FHP) FNC pillar. The FHP Pillar develops deliverable technologies that provide new capabilities that provide Sailors and Marines with the best possible protection from operational threats by reducing morbidity and mortality when casualties occur. The FY 2016 to FY 2017 decrease was due primarily to the completion of FHP-FY11-01 and the planned ramp down of FHP-FY12-02, FHP-FY13-03 and FYP-FY14-01. The FY 2017 to FY 2018 decrease was due primarily to the completion of 1) FHP-FY12-01 Automated Critical Care System (ACCS), which finished integration of software algorithms and hardware, and the performance of FDA tests/trials, and 2) FHP-FY12-02 Saving lives with Emergency Medical Per-fluorocarbons in the Field (SEMPer Fi) for Sea, Air & Land Dysoxia, which down-selected candidate drugs based for the treatment of pulmonary hypertension and conducted a final demonstration of an optimal treatment application; and the planned ramp down of FHP-FY14-01 Acute Care Cover for Severely Injured Limbs (ACCSIL), which in FY18 is finishing the integration of the bioactive coating and external conformal cover, which will conclude the pre-clinical studies. ***FY 2016 Accomplishments:*** EC: FHP-FY11-01 MULTIFUNCTIONAL BLOOD SUBSTITUTE (MFBS)	15.878	15.048	10.910	0.000	10.910

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Multifunctional Blood Substitute (MFBS) - Formulate a resuscitation fluid that provides volume expansion and improves clotting in hemorrhaging combat casualties. EC: FHP-FY12-01 AUTOMATED CRITICAL CARE SYSTEM - Continue Automated Critical Care System (ACCS) - Integrate down-selected hardware with an autonomous software system to monitor and maintain combat causalities with minimal human intervention during a 2-6 hour Casualty Evacuation scenario. EC: FHP-FY12-02 SAVING LIVES WITH EMERGENCY MEDICAL PERFLUOROCARBONS IN THE FIELD (SEMPER FI) FOR SEA, AIR & LAND DYSOXIA -Continue SEMPer Fi for Air Dysoxia - Perform down-select of candidate drugs based on small and large animal testing for treatment of pulmonary hypertension. - Continue SEMPer Fi for Land Blast Kit - Demonstrate an optimal treatment application and overall duration of therapeutic hypothermia for immediate treatment of blast overpressure in small and large animals, including injury to the brain and/or internal organs. EC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue Hypoxia Alert and Mitigation System - Execute laboratory testing to optimize hypoxia-detection algorithms intended for use in high altitude operations. EC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Continue Acute Care Cover for Severely Injured Limbs (ACCSIL) - Integrate outer cover materials and an internal pharmaceutical coating into a single system to improve the clinical outcome of severe wounds on the battlefield. EC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Continue Algorithm - Refine developmental algorithms using experimental data to integrate blast intensity data with cognitive impairment data to predict the likelihood of brain injury after single or multiple blast exposures. - Continue Neuro-Functional Assessment Tool - Identify and refine a non-psychometric device that detects and estimates the severity of traumatic brain injury.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Sensor - Conduct optimization and testing of a self-powered blast sensor that detects and quantifies acceleration, pressure and impulse from a given blast event. ***FY 2017 Plans:*** EC: FHP-FY12-01 AUTOMATED CRITICAL CARE SYSTEM - Complete Automated Critical Care System (ACCS) - Complete integration of software algorithms and hardware, and perform FDA tests/trials as required. EC: FHP-FY12-02 SAVING LIVES WITH EMERGENCY MEDICAL PERFLUOROCARBONS IN THE FIELD (SEMPER FI) FOR SEA, AIR & LAND DYSOXIA - Complete SEMPer Fi for Air Dysoxia - Finish down-select of candidate drugs based on small and large animal testing for treatment of pulmonary hypertension. - Complete SEMPer Fi for Land Blast Kit - Conduct final demonstration of an optimal treatment application and overall duration of therapeutic hypothermia for immediate treatment of blast overpressure in small and large animals, including injury to the brain and/or internal organs. EC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue Hypoxia Alert and Mitigation System - Develop hypoxia alert system hardware and software to guide treatment of casualties in order to sustain performance during high-altitude mountain operations. EC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Continue Acute Care Cover for Severely Injured Limbs (ACCSIL) - Integrate the bioactive coating and external conformal cover, conclude pre-clinical studies, and prepare for initiation clinical studies. EC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Continue Blast Load Assessment: Sense and Test (BLAST) (formerly sensor, algorithm, and neurofunctional assessment tool) - Formulate algorithms to guide medical evaluation decisions after exposure to potential traumatic brain injuries and provide scientific evidence for the development of safe blast exposure limits, enhance the neuro-functional assessment tool to discriminate between traumatic brain injury and other operational impacts, and integrate blast force data from the sensor into the predictive traumatic brain injury algorithm.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: FHP-FY16-01 INCAPACITATION PREDICTION FOR READINESS IN EXPEDITIONARY DOMAINS - AN INTEGRATED COMPUTATIONAL TOOL (I-PREDICT) - Initiate I-PREDICT - Incorporate the high strain rate characteristics of human tissues to allow accurate prediction of military type injuries. ***FY 2018 Base Plans:*** FNC: FHP-FY13-03 EXTREME OPERATIONS: MITIGATING OXYGEN IMBALANCE AT ALTITUDE AND AT DEPTH - Continue Hypoxia Alert and Mitigation System - Continue activities to adapt the hypoxia alert system hardware/ software to guide treatment of casualties in order to sustain performance during high-altitude mountain operations. FNC: FHP-FY14-01 ACUTE CARE COVER FOR SEVERELY INJURED LIMBS (ACCSIL) - Complete Acute Care Cover for Severely Injured Limbs (ACCSIL) - Integrate the bioactive coating and external conformal cover, which will conclude the pre-clinical studies. FNC: FHP-FY14-03 BLAST LOAD ASSESSMENT: SENSE AND TEST (BLAST) - Complete Blast Load Assessment: Sense and Test (BLAST) - Integrate blast force sensor technologies with algorithms relating blast force exposures to the likelihood of injury, and conduct clinical testing of the neuro-functional assessment tool. FNC: FHP-FY16-01 INCAPACITATION PREDICTION FOR READINESS IN EXPEDITIONARY DOMAINS - AN INTEGRATED COMPUTATIONAL TOOL (I-PREDICT) - Continue I-PREDICT - Conduct measurements of the high strain rate characteristics of human tissues to allow an accurate prediction of the severity of battlefield injuries. ***FY 2018 OCO Plans:*** N/A					
Title: FORCENET (FNT) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Forcenet (FNT) FNC Pillar. The FNT pillar develops deliverable technologies that provide new capabilities in Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), networking, navigation, sensors, decision support, cyber-space,	48.830	59.633	61.657	0.000	61.657

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
intelligence, and space technologies that will provide the architectural framework for naval warfare in the information age. The FY 2016 to FY 2017 increase was due primarily to the ramp up of FNT-FY14-02, FNT-FY15-01, FNT-FY15-02 and FNT-FY16-02, and the initiation of FNT-FY17-01, FNT-FY17-02 and FNT-FY17-04. The FY 2017 to FY 2018 increase was due primarily to the planned ramp up of 1) FNT-FY13-03 Silk Thread, which is expanding advanced technology development efforts, 2) FNT-FY15-01 Advanced Airborne Early Warning Electronic Protection (AAEWEP), which is expanding the effort in order to implement techniques to improve the Advanced Hawkeye E2-D electronic protection capability, 3) FNT-FY17-02 Submarine Simultaneous Transmit and Receive (SubSTAR), which will expand to conduct testing of the prototype broadband simultaneous transmit and receive subsystems, and 4) FNT-FY17-04 Resilient Hull/Infrastructure Mechanical & Electrical Security (RHIMES), which will expand to demonstrate resilient software to protect controllers and proactive information shaping capabilities in the laboratory; and the initiation of 1) FNT-FY18-04 A2AD Communication Operations with Nanosats (ACORN), which will Integrate and test a nanosat payload and UHF networking with a digital mobile radio, and 2) FNT-FY18-05 Advanced Coordination Techniques for Distributed EW, which will implement precision geo-location and coordinated engagement techniques, begin a domain analysis for familiarization with relevant Navy systems, and implement techniques for providing real-time propagation channel assessments. ***FY 2016 Accomplishments:*** EC: FNT-FY12-01 ADVANCED TACTICAL DATA LINK (ATDL) - Complete Mission-Based Waveform Controls & Networking - Port baseline waveform and Anti-Access/Area Denial enhancements to reference implementation hardware for field testing and demonstration. EC: FNT-FY12-02 AUTONOMOUS PERSISTENT TACTICAL SURVEILLANCE - Complete Autonomous Information-Based Surveillance Control - Complete integration and testing of information based algorithms for Unmanned Aerial Vehicle (UAV) routing and pathing. - Complete Contextual Enterprise Information - Adapt the analytical services framework and finalize development of real-time enterprise exploitation algorithms for transition and participation in cloud-oriented limited technology experiments.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Mobile Autonomous ISR to C2 Synchronization - Transition to MARCORSYSCOM a service that can track mission task readiness as a function of addressed information fulfillments and unaddressed information deficits. EC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Continue EW Battle Management (EWBM) - Integrate interactive Electronic Warfare displays and alternate communications methods into Navy surface ship combat systems and command and control doctrine. EC: FNT-FY13-03 SILK THREAD - Continue Silk Thread Product 1 - Conduct advanced technology development. - Continue Silk Thread Product 2 - Conduct advanced technology development. EC: FNT-FY13-04 DETECTION AND FUSION FOR REMOTE SENSORS - Continue Adaptive Multi-Int Correlation & Identification (AMICA) - Develop, test and modify algorithms to enable cross-domain information fusion and optimize use of remote sensing assets. - Continue Detection & Classification Algorithms (DCA) - Develop, test and modify algorithms to provide enhanced detection and classification metrics and robust performance under stressing environmental conditions. EC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Continue Adaptive TCPED for ASW Services - Integrate new methods and demonstrate their performance via simulation in limited bandwidth environments. - Continue Data Exfiltration and Networked Platform Interaction - Integrate components with selected waveforms and evaluate communication performance in packages consistent with the size, weight and power constraints of sonobuoys and unmanned underwater vehicles. EC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP) - Continue Advanced AEW Electronic Protection - Conduct integration and testing of E-2D Advanced Hawkeye electronic protection techniques. EC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud (formerly called Naval Tactical Cloud Analytics) - Develop, integrate and validate through Limited Technology Experiments, enhanced ASW, IAMD and EXW situational					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
awareness, decision support analytics and planning algorithms and widgets through mission focused exploitation of all relevant cross-domain data within the Naval Tactical Cloud. EC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Compact, Scalable Integrated RF (Compact-SIRF) - Demonstrate in the laboratory an initial modular Radio Frequency functionality for Size, Weight and Power (SWaP) restricted platforms. - Continue Electronic Warfare Tactical Decision Aid (EW-TACAID) - Demonstrate an Electronic Warfare display with an onboard, integrated, and adaptive high fidelity training capability to improve the warfighters' ability to manage increasingly complex Radio Frequency environments. - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Demonstrate in the laboratory initial techniques for high speed data conversion and multi-function Radio Frequency processing. EC: FNT-FY16-01 BUGLE - Initiate Bugle - Develop and test algorithms for integration into communication systems. EC: FNT-FY16-02 COMBINED EO/IR SURVEILLANCE AND RESPONSE SYSTEM (CESARS) - Initiate Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Develop and test an integrated, multiband laser and sensor architecture that is scalable and modular. - Initiate Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Develop and test an open architecture design for a panoramic, staring, imaging system.					
FY 2017 Plans: EC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Continue EW Battle Management (EWBM) - Integrate Blue and Red force monitoring in Electronic Warfare (EW) planning and execution, and Navy communication and control doctrine. EC: FNT-FY13-03 SILK THREAD - Continue Silk Thread Product 1 - Conduct advanced technology development. - Continue Silk Thread Product 2 - Conduct advanced technology development. EC: FNT-FY13-04 DETECTION AND FUSION FOR REMOTE SENSORS					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Adaptive Multi-Int Correlation & Identification (AMICA) - Develop, test and modify algorithms to enable cross-domain information fusion and optimization of theater and tactical battlespace assets to conduct anti-surface warfare. - Complete Detection & Classification Algorithms (DCA) - Develop, test and modify algorithms to provide enhanced detection and classification metrics and robust performance under stressing environmental conditions. EC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Continue Adaptive TCPED for ASW Services - Develop algorithms and software to assure network connectivity for low latency data sharing and autonomous and adaptive Command and Control (C2) services for coordination of data collection and sharing. - Continue Data Exfiltration and Networked Platform Interaction - Demonstrate and assess the performance of the radio components and waveforms in the host platform in simulated environments. EC: FNT-FY14-03 EXCHANGE OF ACTIONABLE INFORMATION AT THE TACTICAL EDGE (EAITE) - Continue from PE 0603640M Actionable Information Tactical Applications from PE 0603640M - Develop algorithms to assess the content of a machine produced product to a reference Information Requirement (IR) ontology. EC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP) - Continue Advanced AEW Electronic Protection - Implement techniques to improve Advanced Hawkeye E2-D electronic protection capability. EC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud - Test and evaluate new analytic services based on multi-source correlation (Environment, Combat Systems, C2, ISR, EW, Cyber and national/offboard ISR) using property graphs, applying probabilistic analytic models for improved target detection and for historical and predictive analytics supporting ASW, IAMD and EXW amphibious missions. EC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Demonstrate the ability to simultaneously run and change in real time different Electronic Warfare/Electronic INTelligence (EW/ELINT) processing capabilities on the same modular hardware.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Compact, Scalable Integrated RF (Compact-SIRF) - Demonstrate in the laboratory an initial modular Broadband Radio Frequency (RF) front end coupled to a small Intelligence, Surveillance, and Reconnaissance (ISR) collection payload. - Continue Electronic Warfare Tactical Decision Aid (EW-TACAID) - Develop an intuitive Electronic Warfare display with an onboard integrated adaptive training capability to improve the ability of Electronic Support Measures to manage increasingly complex Radio Frequency environments. EC: FNT-FY16-01 BUGLE - Continue Bugle - Develop and test algorithms for integration into communication systems. EC: FNT-FY16-02 Combined EO/IR Surveillance and Response System (CESARS) - Continue Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Begin fabrication of staring, panoramic situational awareness sensors. - Continue Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Begin fabrication of the high resolution sensor. EC: FNT-FY17-01 COMMUNICATIONS AND INTEROPERABILITY FOR INTEGRATED FIRES (CIIF) - Initiate Communications as a Service (CaaS) - Develop, emulate and prototype multi-commodity flow optimization techniques and routing/bridging between Internet Protocol (IP) and non-IP networks with end-to-end Quality of Service (QoS). - Initiate Mission-based Networking for DDS (MiND) - Develop power-control, medium-access control and network topology/routing to enhance bandwidth and scalability, while creating a new Internet Protocol (IP) interface and maintaining interoperability with legacy Cooperative Engagement Capability (CEC) systems. EC: FNT-FY17-02 SUBMARINE SIMULTANEOUS TRANSMIT AND RECEIVE (SUBSTAR) - Initiate Submarine Simultaneous Transmit and Receive (SubSTAR) - Verify concept of submarine broadband antenna enabling simultaneous transmit and receive capability. EC: FNT-FY17-04 RESILIENT HULL/INFRASTRUCTURE MECHANICAL & ELECTRICAL SECURITY (RHIMES) - Initiate SCRAM - Develop and demonstrate software algorithms that protect naval Hull, Mechanical and Electrical (HM&E) systems against cyber threats.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate SCAMM - Develop and demonstrate information shaping cyber capabilities for tactical platforms.					
FY 2018 Base Plans: FNC: FNT-FY13-01 EW BATTLE MANAGEMENT FOR SURFACE DEFENSE - Complete EW Battle Management (EWBM) - Automate blue and red force monitoring in Electronic Warfare (EW) planning and develop techniques to integrate that information into force level tactical decision making. FNC: FNT-FY13-03 SILK THREAD - Complete Silk Thread Product 1 - Complete hardware development and transition to designated programs of record. - Complete Silk Thread Product 2 - Complete hardware development and transition to designated programs of record. FNC: FNT-FY13-04 DETECTION AND FUSION FOR REMOTE SENSORS - Complete Adaptive Multi-Int Correlation & Identification (AMICA) - Extended into FY18 to complete the modification of algorithms to enable cross-domain information fusion and optimization of theater and tactical battlespace assets to conduct anti-surface warfare. FNC: FNT-FY14-02 ADAPTIVE TASKING, COLLECTION, PROCESSING, EXPLOITATION AND DISSEMINATION (TCPED) SERVICES - Complete Adaptive TCPED for ASW Services - Develop algorithms and software to ensure network connectivity for low latency data sharing and autonomous and adaptive Command and Control (C2) services for coordination of data collection and sharing. - Complete Data Exfiltration and Networked Platform Interaction - Demonstrate and assess the performance of the radio components and waveforms in a host platform in simulated environments. FNC: FNT-FY14-03 EXCHANGE OF ACTIONABLE INFORMATION AT THE TACTICAL EDGE (EAITE) - Continue Actionable Information Tactical Applications - Develop gisting algorithms to assess the content of a machine produced product to a reference ontology. (In FY19, this FNC Product will be realigned within this PE to IW-FY14-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY15-01 ADVANCED AIRBORNE EARLY WARNING ELECTRONIC PROTECTION (AAEWEP)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Advanced AEW Electronic Protection - Test and improve Airborne Early Warning (AEW) electronic protection capabilities within a relevant environment. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-01 under a new Air Warfare R-2 Activity) FNC: FNT-FY15-02 DATA FOCUSED NAVAL TACTICAL CLOUD - Continue Data Focused Naval Tactical Cloud - Develop predictive motion models, enemy course-of-action and intent analytics with multi security levels for integrated fires and integrated air and missile defense operational intelligence. (In FY19, this FNC Product will be realigned within this PE to IW-FY15-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY15-04 SCALABLE INTEGRATED RF SYSTEM FOR UNDERSEA PLATFORMS (SIRFSUP) - Continue Compact, Scalable Integrated RF (Compact-SIRF) - Implement and evaluate spectral interference mitigation and coordination techniques during laboratory and at-sea tests. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-02 under a new Undersea Warfare R-2 Activity) - Complete Electronic Warfare Tactical Decision Aid (EW-TACAID) - Implement and test techniques developed to provide efficient operator interfaces in support of netted sensor and coordinated EW operations. - Continue Scalable Integrated RF for Submarines (SIRF-Sub) - Demonstrate prototype effectiveness via testing in laboratory and at-sea scenarios. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-02 under a new Undersea Warfare R-2 Activity) FNC: FNT-FY16-01 BUGLE - Continue Bugle - Conduct testing and a demonstration of advanced waveforms. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY16-02 COMBINED EO/IR SURVEILLANCE AND RESPONSE SYSTEM (CESARS) - Continue Multispectral EO/IR Countermeasures against Advanced Threats (MEIRCAT) - Implement final designs through the fabrication of the high resolution sensor and optics hardware, laser hardware, turret hardware, and processing and system controls. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-03 under a new Information Warfare R-2 Activity) - Continue Shipboard Panoramic EO/IR Cueing and Surveillance System (SPECSS) - Demonstrate a large Focal Plane Array (FPA) stitching and panoramic capability. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-03 under a new Information Warfare R-2 Activity)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: FNT-FY17-01 COMMUNICATIONS AND INTEROPERABILITY FOR INTEGRATED FIRES (CIIF) - Continue Communications as a Service (CaaS) - Emulate, test and develop software for date forwarding and routing protocols between IP and non-IP networked data links. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-01 under a new Information Warfare R-2 Activity) - Continue Mission-Based Networking for DDS (MiND) - Initiate firmware porting and the porting of waveform software code to the emulation platform. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-01 under a new Information Warfare R-2 Activity) FNC: FNT-FY17-02 SUBMARINE SIMULTANEOUS TRANSMIT AND RECEIVE (SUBSTAR) - Continue Submarine Simultaneous Transmit and Receive (SubSTAR) - Test and improve the prototype broadband simultaneous transmit and receive subsystems. (In FY19, this FNC Product will be realigned within this PE to UW-FY17-01 under a new Undersea Warfare R-2 Activity) FNC: FNT-FY17-04 RESILIENT HULL/INFRASTRUCTURE MECHANICAL & ELECTRICAL SECURITY (RHIMES) - Continue SCAMM - Demonstrate proactive information shaping capabilities in the laboratory. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-02 under a new Information Warfare R-2 Activity) - Continue SCRAM- Demonstrate resilient software to protect redundant controllers and controllers without redundancy in a laboratory environment. (In FY19, this FNC Product will be realigned within this PE to SW-FY17-01 under a new Surface Warfare R-2 Activity) FNC: FNT-FY18-04 NANOSAT COMMUNICATIONS FOR A2AD OPERATIONS - Initiate Nanosat Communications Payloads - Integrate and test a nanosat payload to verify communications performance in the UHF-band in a laboratory environment. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-02 under a new Information Warfare R-2 Activity) - Initiate Shipboard Integration - Integrate and test UHF networking with a digital mobile radio using a shipboard antenna and tracking. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-02 under a new Information Warfare R-2 Activity) FNC: FNT-FY18-05 ADVANCED COORDINATION TECHNIQUES FOR DISTRIBUTED EW - Initiate Coordinated Radio Frequency EW (CRFEW) - Implement precision geo-location and coordinated engagement techniques to surface ship applications in order to provide surface ships with emitter geo-location					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
capabilities and the ability to coordinate electronic attack engagements on battlespace emitters. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) - Initiate Next Generation Surface Electronic Warfare User Interface - Begin a domain analysis for familiarization with relevant Navy systems, programs of record, technical performers, and the system constraints imposed on human machine interface development. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) - Initiate Propagation Channel Assessment and Prediction (PCAP) - Implement techniques for providing real-time propagation channel assessments using shipboard and netted radio frequency sensors and data communication infrastructures. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-03 under a new Information Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: POWER AND ENERGY (P&E) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Power and Energy (P&E) FNC pillar. The P&E Pillar develops deliverable technologies that provide new capabilities in energy security, efficient power and energy systems, high energy and pulse power. The FY 2016 to FY 2017 increase was due primarily to the ramp-up of P&E-FY15-03 and the initiation of P&E-FY17-02. ***FY 2016 Accomplishments:*** EC: P&E-FY12-01 RENEWABLE-SUSTAINABLE EXPEDITIONARY POWER - Complete Renewable Thermal Engine - Conduct full-scale testing and a TRL 6 demonstration, and deliver tactical power system prototype to USMC transition sponsor. EC: P&E-FY12-03 LONG ENDURANCE UNDERSEA VEHICLE PROPULSION - Continue Air Independent Propulsion System - Conduct Phase II fuel cell energy system integration into a UUV energy section and conduct TRL-6 land-based testing and transition planning. EC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS	9.476	16.641	15.817	0.000	15.817

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Develop final Phase II design for prototype circuit protection devices and initiate development of the devices and the associated test environment. EC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY - Continue Compact High Density Tactical Energy Storage - Develop and test a multifunction energy storage module system, which integrates target subcomponent technologies. - Continue Multi-Function High Density Shipboard Energy Storage - Develop a subscale ship multi-function energy storage module integrated system and conduct initial shipboard testing. ***FY 2017 Plans:*** EC: P&E-FY12-03 LONG ENDURANCE UNDERSEA VEHICLE PROPULSION - Continue Air Independent Propulsion System - Continue conduct Phase II fuel cell energy system integration into a UUV energy section and conduct TRL-6 land-based testing and transition planning. EC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS - Continue High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Select the appropriate 20kV semiconductor devices and develop the related circuit topology and fault sensing algorithms. EC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY - Continue Multi-Function High Density Shipboard Energy Storage - Develop a ship multi-function energy storage module integrated system and complete development of a safe non-propagating battery subsystem. - Continue Compact High Density Tactical Energy Storage - Initiate development of a full scale multifunction energy storage module with hybrid power system interface. EC: P&E-FY17-02 TORPEDO ADVANCED PROPULSION SYSTEM (TAPS) - Initiate Torpedo Advanced Propulsion System (TAPS) - Initiate limited component development and testing. ***FY 2018 Base Plans:*** FNC: P&E-FY12-03 LONG ENDURANCE UNDERSEA VEHICLE PROPULSION - Complete Air Independent Propulsion System - Complete Phase II fuel cell energy system integration into a UUV energy section and conduct TRL-6 land-based testing and transition planning.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: P&E-FY14-01 EFFICIENT AND POWER DENSE ARCHITECTURE AND COMPONENTS - Complete High Power Solid State Circuit Protection for Power Distribution and Energy Storage - Complete circuit protection component testing in a relevant system environment. FNC: P&E-FY15-03 MULTIFUNCTION ENERGY STORAGE FOR NAVY / USMC APPLICATIONS TO MAXIMIZE OPERATIONAL EFFECTIVENESS AND EFFICIENCY - Complete Compact High Density Tactical Energy Storage - Complete development, demonstration, and testing of a full-scale Technology Readiness Level (TRL) 6 Compact High Density Tactical Energy Storage module with a hybrid power system interface. - Continue Multi-Function High Density Shipboard Energy Storage - Develop and demonstrate a megawatt scale multifunction energy storage system with an incorporated non-propagating battery subsystem. FNC: P&E-FY17-02 TORPEDO ADVANCED PROPULSION SYSTEM (TAPS) - Continue Torpedo Advanced Propulsion System (TAPS) - Conduct limited component development and testing, preparing for a down-selection to one technology. ***FY 2018 OCO Plans:*** N/A					
Title: SEA BASING (BAS)	3.719	0.000	0.000	0.000	0.000
Description: This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Sea Basing (BAS) FNC pillar. The BAS Pillar develops deliverable logistics, shipping and at-sea transfer technologies that provide new capabilities for projecting expeditionary force from the sea base and providing sea based joint operational independence through improved connector, at-sea transfer and shipboard logistical capabilities. The FY 2016 to FY 2017 decrease was due to the completion of BAS-FY11-01. ***FY 2016 Accomplishments:*** EC: BAS-FY11-01 CONNECTORS AND THE SEA BASE - Complete Advanced Mooring System - Demonstrate a fully capable advanced mooring system and transition it to sponsors.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Environmental Ship Motion Forecasting - Develop wave and ship motion forecasting technologies. ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A					
Title: SEA SHIELD (SHD) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE that are aligned to the Sea Shield (SHD) FNC pillar. The SHD Pillar develops deliverable technologies that provide new capabilities in theater air and missile defense, anti-submarine warfare, mine countermeasures, defensive surface warfare, global defensive assurance, anti-terrorism, and fleet/force protection. The FY 2016 to FY 2017 decrease was due primarily to the completion of SHD-FY10-01, SHD-FY10-03, SHD-FY11-01, SHD-FY12-01 and SHD-FY12-03, the planned ramp down of SHD-FY13-05, SHD-FY14-02 and SHD-FY16-05, and the movement of SHD-FY16-OSD out of the FNC Program into PE 0603782N. The FY 2017 to FY 2018 decrease was due primarily to the completion of 1) SHD-FY13-05 High Altitude ASW (HAASW) from the P-8, which will finish the demonstration of next generation multi-static active capability sonobuoys, and 2) SHD-FY13-07 USV Payloads for Single Sortie Mine Countermeasures, which will perform a final system demonstration of the neutralizer test bed, the launch, recovery, communications, and recharging systems, and the automatic target recognition capability; and the planned ramp down of 1) SHD-FY12-04 Detection and Neutralization of Near-Surface Drifting-Oscillating Mines, which will finish in FY18 after completing a final demonstration of the multi-sensor detection of ocean mines, 2) SHD-FY15-07 Hyper Velocity Projectile, which will finish in FY18 after the assembly of hypervelocity projectiles in preparation for a full-up launch, and 3) SHD-FY16-06 Next Generation Airborne Passive System (NGAPS), which will wind down the testing and integration of hardware. ***FY 2016 Accomplishments:*** EC: SHD-FY10-01 ANTI-SHIP MISSILE DEFENSE TECHNOLOGIES	75.882	68.870	59.974	0.000	59.974

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete Enhanced Lethality Guidance Algorithms (ELGA) - Demonstrate and validate the guidance algorithm with respect to exit criteria. - Complete Enhanced Maneuverability Missile Airframe (EMMA) - Demonstrate the dual pulse rocket motor and integrated thrust vector control, and deliver the final rocket motor design. EC: SHD-FY10-03 ADVANCED SONAR TECHNOLOGY FOR HIGH CLEARANCE RATE MCM - Complete Long Range LFBB Sonar (AUV Platform Option) - Perform final system demonstration and exit event. EC: SHD-FY10-05 AFFORDABLE VECTOR SENSOR TOWED ARRAY AND SIGNAL PROCESSING - Complete Vector Sensor Towed Array - Finalize the demonstration of a thin, twin-line capability in a single array. EC: SHD-FY11-01 TORPEDO COMMON HYBRID FUZING SYSTEM - Complete Torpedo Common Hybrid Fuzing System - Conduct final field testing, demonstrate a prototype system, and transition the system to acquisition for engineering development. EC: SHD-FY12-01 FORCE LEVEL RADAR RESOURCE MANAGEMENT FOR INTEGRATED AIR AND MISSILE DEFENSE (IAMD) - Complete Radar Resource Manager for IAMD - Conduct a final demonstration of the Radar Resource Manager and validate the technology deliverable with respect to exit criteria. EC: SHD-FY12-03 SONAR AUTOMATION - Complete Active Sonar Automation - Evaluate and deliver algorithms for use in current active sonar systems that improve operator performance and reduce workload. - Complete Passive Sonar Automation - Evaluate and deliver algorithms for use in current passive sonar systems that improve operator performance and reduce workload when used against quiet submarines in the presence of clutter. EC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Continue Compact Modular Sensor-Processing Suite (CMSS) - Demonstrate multi-sensor detection of ocean mines from a manned helicopter.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR - Continue Cooperative Networked Radar - Conduct integration and testing for cross platform radar operation. EC: SHD-FY13-05 HIGH ALTITUDE ASW (HAASW) FROM THE P-8 - Continue Next Generation Multistatic Active Capability (NGMAC) - Improve and evaluate the performance of hardware and software for use in improving the Multistatic Active Capability sonobuoys and P-8A signal processing. - Complete Unmanned Targeting Air System (UTAS) - Integrate compact magnetometers into Unmanned Air System (UAS) candidates and develop test plans for a maneuver table to compare Tier 1 and Tier 2 UAS's for the ASW mission. EC: SHD-FY13-07 USV PAYLOADS FOR SINGLE SORTIE MINE COUNTERMEASURES - Continue MCM Payload Automation for Data Analysis - Develop and extend adaptive Automatic Target Recognition approaches to advanced environmental models supporting Net-centric Sensor Analysis for MIW (NSAM). - Continue MCM Payload Automation for Planning - Develop and extend adaptive Automatic Target Recognition approaches to advanced environmental models supporting the Mine-warfare Environmental Decision-Aid Library (MEDAL). - Continue Single Sortie MCM Detect-to-Engage Payload - Design and develop launch, recovery, communications, and recharging systems, and associated algorithms and vehicle payload support hardware. - Continue USV-based Mine Neutralization - Develop and modify the processing and hardware for neutralization technologies. EC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue Concept C Countermeasure - Develop test plan for array design improvements. - Continue ATT Timeline Compression (ATTTC) - Begin in-water demonstrations. - Complete HVU Mounted Sonar - Complete array electronics and fabricate the first transmit/receive panels, validating performance in a lake test. EC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Continue Autonomous Threat Detection and Localization - Develop and integrate node deployment modules and the weapons payload, and conduct functional testing.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Remote Command & Control - Develop communications package improvements and conduct functional component and system testing. - Continue Tactical Positioning & Fire Control - Conduct testing and evaluation, and integrate improved sensor node hardware and detection, classification, localization and targeting algorithms. EC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S (formerly Terminator E, R and S) - Validate the Ship Self-Defense System (SSDS) algorithm and the fire control loop concept using modeling and simulation tools. EC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Initiate MCM Task Force Planning - Extend algorithms for squadron-level planning and re-planning. - Initiate Expeditionary MCM Automated Data Analysis - Develop advanced automatic target recognition capabilities for Synthetic Aperture Sonar (SAS) and closed-aperture SAS. EC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Continue Hyper Velocity Projectile - Design, fabricate and begin assembly of hypervelocity projectiles in preparation for a full-up launch to validate common interfaces for powder gun and railgun launch. EC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Initiate Ship-launched EW Extended Endurance Decoy (SEWEED) - Build mockups of the fuselage, rotor and antenna cavity for RF payload antenna isolation experiments. EC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Initiate Surface Ship Periscope Detection and Discrimination (SSPDD) - Customize hardware interfaces for assembly and integration of system level components. EC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS) - Initiate Next Generation Airborne Passive System (NGAPS) - Develop algorithms and hardware for field communications control, health monitoring, mission planning and contact separation and correlation. EC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Initiate Softkill Performance and Real-Time Assessment (SPARTA) - Develop and optimize performance assessment algorithms, and align them with a pending system requirements review.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
EC: SHD-FY16-OSD MODULAR UNDERSEA EFFECTORS (MUSE) - Initate Modular UnderSea Effectors (MUSE) - Commence design of delivery and mooring approaches, technologies to integrate UUV-based and encapsulated undersea weapons, and prototyping of advanced sensors.					
FY 2017 Plans: EC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Continue Compact Modular Sensor-Processing Suite (CMSS) - Complete Compact Modular Sensor-Processing Suite (CMSS) - Demonstrate multi-sensor detection of ocean mines from a manned helicopter. EC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR - Continue Cooperative Networked Radar - Initiate test and demonstration planning for software algorithms and techniques for cross-platform radar operation that will deliver enhanced sensitivity. EC: SHD-FY13-05 HIGH ALTITUDE ASW (HAASW) FROM THE P-8 - Complete Next Generation Multistatic Active Capability (NGMAC) - Demonstrate the Next Generation Multistatic Active Capability sonobuoys in a relevant at sea Navy environment. EC: SHD-FY13-07 USV PAYLOADS FOR SINGLE SORTIE MINE COUNTERMEASURES - Complete USV-based Mine Neutralization - Perform final system demonstration of Neutralizer Test Bed and associated technologies. - Complete Single Sortie MCM Detect-to-Engage Payload - Perform final system demonstration of launch, recovery, communications, recharging systems, and associated algorithms/vehicle payload support hardware. - Complete MCM Payload Automation for Data Analysis - Demonstrate system-level Automatic Target Recognition (ATR) capability at technology development exit event. - Complete MCM Payload Automation for Planning - Demonstrate component level risk analysis in war game exit event. EC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue ATT Timeline Compression (ATTTC) - Conduct in-water component testing and data collection.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Concept C Countermeasure - Conduct bench testing of array design improvements and prepare for in-water tests. EC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Continue Tactical Positioning & Fire Control - Demonstrate node deployment modules & weapons payload integration. - Continue Autonomous Threat Detection and Localization - Develop final sensor node hardware/software and perform functional testing. - Continue Remote Command & Control - Demonstrate an integrated communications package. EC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S (formerly Terminator E, R and S) - Validate the Ship Self-Defense System (SSDS) algorithm and the fire control loop concept using modeling and simulation tools. EC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Continue MCM Task Force Planning - Develop approach to automate data management from Naval message traffic to support re-planning, scheduling, and situational awareness. - Continue Expeditionary MCM Automated Data Analysis - Extend in situ retraining algorithms to multi-band advanced sonar systems. EC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Continue Hyper Velocity Projectile - Design, fabricate and begin assembly of hypervelocity projectiles in preparation for a full-up launch to validate common interfaces for powder gun and railgun launches. EC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Continue Ship-launched EW Extended Endurance Decoy (SEWEED) - Build mockups of the fuselage, rotor, and antenna cavity for RF payload antenna isolation experiments. EC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Continue Surface Ship Periscope Detection and Discrimination (SSPDD) - Customize hardware interfaces for assembly and integration of system level components. EC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Next Generation Airborne Passive System (NGAPS) - Integrate algorithms with hardware for field communications, control, health monitoring, mission planning and contact separation and correlation. EC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Continue Softkill Performance and Real-Time Assessment (SPARTA) - Develop and optimize performance assessment algorithms and align them with a pending system requirements review. EC: SHD-FY16-OSD MODULAR UNDERSEA EFFECTORS (MUSE) - Continued in PE 0603782N. EC: SHD-FY17-02 AUTONOMOUS UNMANNED SURFACE VEHICLES FOR MINE WARFARE (MIW) - Initiate Autonomous Situational Awareness and Hazard Avoidance System for USVs - Integrate autonomous control on an Unmanned Surface Vehicle (USV) and demonstrate at-sea. - Initiate High Temperature Superconducting (HTS) Magnetic Influence Sweep Payload for USVs - Integrate the superconducting system on an Unmanned Surface Vehicle (USV) and demonstrate at-sea. - Initiate Underway Refueling and Data Transfer for USVs and RMMVs - Integrate underway refueling and data transfer technology with Unmanned Surface Vehicles (USVs) and Remote Multi-Mission Vehicles (RMMVs) and demonstrate at-sea. EC: SHD-FY17-05 DEEP RELIABLE ACOUSTIC PATH EXPLOITATION SYSTEM (DRAPES) - Initiate Deep Reliable Acoustic Path Exploitation System (DRAPES) - Integrate algorithms and hardware for undersea communications, health monitoring, and contact separation and correlation. ***FY 2018 Base Plans:*** FNC: SHD-FY12-04 DETECTION AND NEUTRALIZATION OF NEAR-SURFACE DRIFTING-OSCILLATING MINES - Complete Compact Modular Sensor-Processing Suite (CMSS) - Finish the final Demonstration of the multi-sensor detection of ocean mines that had to be extended into FY18. FNC: SHD-FY13-01 COOPERATIVE NETWORKED RADAR - Continue Cooperative Networked Radar - Conduct testing and demonstrating software algorithms and techniques for cross-platform radar operation deliver enhanced sensitivity.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: SHD-FY14-02 FULL SECTOR TORPEDO DEFENSE - Continue ATT Timeline Compression (ATTTC) - Conduct a static in-water demonstration. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-03 under a new Surface Warfare R-2 Activity) - Continue Concept C Countermeasure - Conduct an at-sea static assessment of the complete subsystem. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-03 under a new Surface Warfare R-2 Activity) FNC: SHD-FY14-04 ADVANCED UNDERSEA WEAPON SYSTEM (AUWS) - Continue Autonomous Threat Detection and Localization - Conduct testing and preparations for an at-sea demonstration of the full detection, classification, localization, and tracking sequence on an Extra Large Unmanned Undersea Vehicle (XLUUV). - Continue Remote Command & Control - Conduct testing and preparations for an at-sea demonstration of full command and control functionality on an Extra Large Unmanned Undersea Vehicle (XLUUV). - Continue Tactical Positioning & Fire Control - Conduct testing and preparations for an at-sea demonstration of the sensor placement and firing solution functionality on an Extra Large Unmanned Undersea Vehicle (XLUUV). FNC: SHD-FY14-08 TERMINATOR (T3) - Continue Terminator S - Validate the Ship Self-Defense System (SSDS) algorithm and the fire control loop concept using modeling and simulation tools. (In FY19, this FNC Product will be realigned within this PE to SW-FY14-04 under a new Surface Warfare R-2 Activity) FNC: SHD-FY15-03 AUTOMATION FOR UXV-BASED MCM - Continue Expeditionary MCM Automated Data Analysis - Collect at-sea training data for multi-band automatic target recognition and fusion algorithms. (In FY19, this FNC Product will be realigned within this PE to EMW-FY15-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue MCM Task Force Planning - Conduct experiments and a table-top war-game on the re-planning and planning of risk, using the results to update the algorithms and human-machine interface approach. (In FY19, this FNC Product will be realigned within this PE to EMW-FY15-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) FNC: SHD-FY15-07 HYPER VELOCITY PROJECTILE - Complete Hyper Velocity Projectile - Design, fabricate and begin assembly of hypervelocity projectiles in preparation for a full-up launch to validate common interfaces for powder gun and railgun launches.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
FNC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED) - Continue Ship-launched EW Extended Endurance Decoy (SEWEED) - Conduct flight testing of the decoy demonstrator vehicle and isolation testing of the payload module. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-04 under a new Information Warfare R-2 Activity) FNC: SHD-FY16-05 SURFACE SHIP PERISCOPE DETECTION AND DISCRIMINATION (SSPDD) - Continue Surface Ship Periscope Detection and Discrimination (SSPDD) - Continue development and commence preparation of an initial test plan for the government-reference prototype sensor and data fusion system. FNC: SHD-FY16-06 NEXT GENERATION AIRBORNE PASSIVE SYSTEM (NGAPS) - Continue Next Generation Airborne Passive System (NGAPS) - Test and integrate hardware for field communications, control, health monitoring, mission planning and contact separation/correlation. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-02 under a new Air Warfare R-2 Activity) FNC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA) - Continue Softkill Performance and Real-Time Assessment (SPARTA) - Develop and optimize performance assessment algorithms and align them with a pending system requirements review. (In FY19, this FNC Product will be realigned within this PE to IW-FY16-05 under a new Information Warfare R-2 Activity) FNC: SHD-FY17-02 AUTONOMOUS UNMANNED SURFACE VEHICLES FOR MINE WARFARE (MIW) - Continue Autonomous Situational Awareness and Hazard Avoidance System for USVs - Demonstrate with an Unmanned Surface Vehicle (USV) an autonomous situational awareness and avoidance capability that enables avoidance of fixed and moving hazards, with the ability to regain track and revisit missed areas using low bandwidth communications. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue High Temperature Superconducting (HTS) Magnetic Influence Sweep Payload for USVs - Demonstrate improved clearance rates and reduced risk to Unmanned Surface Vehicles (USVs) from mine detonation, and improved mean time between maintenance. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - Continue Underway Refueling and Data Transfer for USVs and RMMVs - Demonstrate automated/unmanned refueling of an Unmanned Surface Vehicle (USV) with data download/upload using a second unmanned platform					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
in up to sea state 3. (In FY19, this FNC Product will be realigned within this PE to EMW-FY17-02 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) FNC: SHD-FY17-05 DEEP RELIABLE ACOUSTIC PATH EXPLOITATION SYSTEM (DRAPES) - Continue Deep Reliable Acoustic Path Exploitation System (DRAPES) - Integrate algorithms and hardware for undersea communications, health monitoring, and contact separation/correlation. (In FY19, this FNC Product will be realigned within this PE to IW-FY17-03 under a new Information Warfare R-2 Activity) FNC: SHD-FY18-08 FORCE-LEVEL INTEGRATED FIRES REAL-TIME ENGAGEMENT COORDINATION AND PERFORMANCE ESTIMATION (FIRECAPE) - Initiate FIRECAPE Algorithms - Begin development of prototype tactical software and testing on tactical hardware to validate the performance of algorithms against complex threat raids. (In FY19, this FNC Product will be realigned within this PE to IW-FY18-04 under a new Information Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Title: SEA STRIKE (STK) ***Description:*** This R-2 Activity contains all Future Naval Capabilities (FNC) Program Enabling Capability (ECs) investments in this PE. The Sea Strike (STK) FNC pillar develops deliverable technologies that provide new capabilities in power projection and deterrence, precise and persistent offensive power, weapons, aircraft, and expeditionary warfare. The FY 2016 to FY 2017 increase was due primarily to the planned ramp-up of STK-FY15-01, STK-FY15-02, STK-FY16-01 and STK-FY17-04. The FY 2017 to FY 2018 increase was due primarily to the planned ramp up of 1) STK-FY13-01 Long Range RF Find, Fix and ID, which will conduct testing, mitigate exceptions, and demonstrate the Long Range Find, Fix, and ID capability, 2) STK-FY15-01 Synthetic Aperture Radar Electronic Protection (SAREP), which will test, assess, and improve the synthetic aperture radar electronic protection capability in relevant littoral environments, 3) STK-FY15-02 Rotor-craft Advanced Protection from IR/EO/RPG (RAPIER), which will demonstrate the technological feasibility of a Rocket Propelled Grenade (RPG) hard-kill defense system and test the final Infra-Red Countermeasures (IRCM) prototype system to be used in the field test demonstration of countermeasures	42.882	47.467	49.314	0.000	49.314

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
techniques, 4) STK-FY15-03 Extended Range Modular Undersea Heavyweight Vehicle (ER MUHV), which will conduct in-water testing of autonomy algorithms and the multiband and hybrid sonar, inertial navigation, and fiber optic systems, and 5) STK-FY16-01 Extended-Range Targeting (E-RAT), which will conduct technology concept demonstrations of subsystem models; and the initiation of STK-FY18-01 Precision Electronic Attack Technologies (PEAT), which will develop and implement Electronic Warfare (EW) techniques and supporting technology for multi-platforms effects and for intra-platform synchronized EW effects. ***FY 2016 Accomplishments:*** EC: STK-FY09-03 ENHANCED WEAPONS TECHNOLOGIES - Complete High Speed Components - Finish development and conduct final testing required for transition. EC: STK-FY12-01 SUBMARINE SURVIVABILITY - ELECTRONIC WARFARE - Complete Coherent Electronic Attack for Submarines (CEAS) - Develop prototype hardware and software for insertion of advanced electronic support and electronic attack techniques into a payload form factor consistent with compact applications, including submarine masts. EC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID - Continue Long Range Find, Fix and ID - Conduct integration and testing for moving maritime Radio Frequency identification algorithms. EC: STK-FY13-02 HOSTILE FIRE (HF) SUPPRESSION - Complete Hostile Fire Suppression System - Demonstrate real-time reactive hostile shooter suppression in a field test demonstration. EC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Continue Anti-Surface Warfare (ASuW) Weapon Upgrade - Demonstrate and evaluate relevant algorithms during at-sea testing. EC: STK-FY13-04 AIM-9X ENABLERS (AXE) - Continue SMOKE - Design, develop and demonstrate an advanced propulsion system for a future Air-to-Air missile. EC: STK-FY14-01 BANK SHOT					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Bank Shot - Develop the software architecture and associated algorithms that provide for data fusion. EC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Continue Collaborative Anti-Surface Warfare Engagement (CASE) - Demonstrate software operability and inter-operability for flexible weapon behaviors at the salvo level in an Anti-Access, Area-Denial environment. - Continue Collaborative Electronic Attack (CEA) - Integrate and test highly advanced electronic attack techniques to provide an advanced collaborative electronic attack capability against surface targets. EC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Conduct integration and testing of synthetic aperture radar electronic protection algorithms and techniques. EC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Demonstrate the technological feasibility of a Rocket Propelled Grenade (RPG) hard-kill defense system and its component operability on the MV-22. - Continue Multi-Spectral EO/IR Seeker Defeat - Develop Electro-Optical/Infrared (EO/IR) countermeasure high power sources and supporting optics that can be integrated into Joint and Allied systems. EC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Conduct in-water autonomy open-loop testing. - Continue MUHV Sensors, Navigation and Guidance - Conduct in-water navigation system demonstrations (open and closed loop). EC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Continue Extended-Range Targeting (E-RAT) - Conduct concept and technology demonstrations of subsystem models to assess the feasibility and operability of new technologies for targeting and fire control modes at extended ranges. EC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM) - Initiate Reactive Electronic Attack Measures (REAM) - Develop a test bed for testing enhanced Radio Frequency sensing algorithms and an integration strategy for targeted transition systems. EC: STK-FY17-04 ALPO					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue ALPO - Begin development of an advanced signal processing system in a relevant tactical environment.					
FY 2017 Plans: EC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID - Continue Long Range Find, Fix and ID - Test and verify performance of algorithms for achieving Radio Frequency (RF) identification of moving maritime contacts. EC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Continue Anti-Surface Warfare (ASuW) Weapon Upgrade - Evaluate system performance based during in-water testing. EC: STK-FY13-04 AIM-9X ENABLERS (AXE) - Continue SMOKE - Design, develop and demonstrate an advanced propulsion system for a future Air-to-Air missile. EC: STK-FY14-01 BANK SHOT - Complete Bank Shot - Develop the software architecture and associated algorithms that provide for data fusion. EC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Continue Collaborative Anti-Surface Warfare Engagement (CASE) - Demonstrate software operability and interoperability for flexible weapon behaviors at the salvo level in an Anti-Access, Area-Denial environment. - Continue Collaborative Electronic Attack (CEA) - Perform lab testing of Collaborative Peer-to-Peer Adaptable Electronic Warfare (EW) Mission Prioritization and threat classification algorithms. EC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Test algorithms and techniques to improve synthetic aperture radar electronic protection. EC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Demonstrate the technological feasibility of a Rocket Propelled Grenade (RPG) hard-kill defense system and its component operability.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue Multi-Spectral EO/IR Seeker Defeat - Begin subcomponent design integration of the Electro-Optic (EO) source to be used in combination with an existing Infra-Red CounterMeasures (IRCM) Laser to support transition. EC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Conduct open-loop in-water demonstrations of autonomy algorithms for mission planning, waypoint navigation, and vehicle health assessment. - Continue MUHV Sensors, Navigation and Guidance - Conduct in-water demonstrations of multiband and hybrid sonar, inertial navigation, and fiber optic systems. EC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Continue Extended-Range Targeting (E-RAT) - Conduct technology concept demonstrations of subsystem models to assess the feasibility and operability of new technologies for the targeting and fire control modes at extended ranges. EC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM) - Continue Reactive Electronic Attack Measures (REAM) - Design and integrate adaptive capabilities into an advanced prototype within an existing Electronic Attack (EA) suite subsystem and adaptive threat simulator. EC: STK-FY17-04 ALPO - Continue ALPO - Continue technology development of an advanced signal processing system in a relevant tactical environment.					
FY 2018 Base Plans: FNC: STK-FY13-01 LONG RANGE RF FIND, FIX AND ID - Complete Long Range Find, Fix and ID - Conduct testing, mitigate exceptions, and demonstrate the Long Range Find, Fix, and ID capability. FNC: STK-FY13-03 ANTI-SURFACE WARFARE (ASUW) WEAPON UPGRADE - Complete Anti-Surface Warfare (ASuW) Weapon Upgrade - Demonstrate a phase II capability in a tactically relevant environment. FNC: STK-FY13-04 AIM-9X ENABLERS (AXE)					

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Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Complete SMOKE - Design, develop and demonstrate an advanced propulsion system for a future air-to-air missile. FNC: STK-FY14-01 BANK SHOT - Complete Bank Shot - Develop the software architecture and associated algorithms that provide for data fusion. FNC: STK-FY14-03 INTELLIGENT COLLABORATIVE ENGAGEMENT (ICE) - Complete Collaborative Anti-Surface Warfare Engagement (CASE) - Demonstrate software operability and interoperability for flexible weapon behaviors at the salvo level in an anti-access area-denial environment. - Continue Collaborative Electronic Attack (CEA) - Perform bench-top and hardware-in-the-loop testing of the electronic support/electronic attack hardware and cognitive components. (In FY19, this FNC Product will be realigned within this PE to IW-FY14-03 under a new Information Warfare R-2 Activity) FNC: STK-FY15-01 SYNTHETIC APERTURE RADAR ELECTRONIC PROTECTION (SAREP) - Continue Synthetic Aperture Radar Electronic Protection - Test, assess, and improve the synthetic aperture radar electronic protection capability in relevant littoral environments. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-03 under a new Air Warfare R-2 Activity) FNC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER) - Continue Helicopter Active RPG Protection (HARP) - Demonstrate the technological feasibility of a Rocket Propelled Grenade (RPG) hard-kill defense system and its component operability. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-04 under a new Air Warfare R-2 Activity) - Continue Multi-Spectral EO/IR Seeker Defeat - Build and test the final Infra-Red Countermeasures (IRCM) prototype system to be used in the field test demonstration of countermeasures techniques, build expendables based on derived expendable requirements, and perform radiometric measurements in the field. (In FY19, this FNC Product will be realigned within this PE to AW-FY15-04 under a new Air Warfare R-2 Activity) FNC: STK-FY15-03 EXTENDED RANGE MODULAR UNDERSEA HEAVYWEIGHT VEHICLE (ER MUHV) - Continue MUHV Autonomy Suite - Conduct in-water testing and assessment of autonomy algorithms for mission planning, waypoint navigation and vehicle health. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-03 under a new Undersea Warfare R-2 Activity)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue MUHV Sensors, Navigation and Guidance - Conduct in-water demonstrations for maturation assessment of the multiband and hybrid sonar, inertial navigation, and fiber optic systems. (In FY19, this FNC Product will be realigned within this PE to UW-FY15-03 under a new Undersea Warfare R-2 Activity) FNC: STK-FY16-01 EXTENDED-RANGE TARGETING (E-RAT) - Complete Extended-Range Targeting (E-RAT) - Conduct concept and technology demonstrations of subsystem models to assess the feasibility and operability of new technologies for targeting and fire control modes at extended ranges. FNC: STK-FY16-02 REACTIVE ELECTRONIC ATTACK MEASURES (REAM) - Continue Reactive Electronic Attack Measures (REAM) - Test and improve reactive electronic attack measures in the representative environment. (In FY19, this FNC Product will be realigned within this PE to AW-FY16-04 under a new Air Warfare R-2 Activity) FNC: STK-FY17-04 ALPO - Complete ALPO - Complete the proof of technological feasibility and assessment phase of an advanced signal processing system in a relevant tactical environment. FNC: STK-FY18-01 PRECISION ELECTRONIC ATTACK TECHNOLOGIES (PEAT) - Initiate Multi-platform Retrodirective EW - Develop and implement Electronic Warfare (EW) techniques and supporting technology for multi-platforms effects. (In FY19, this FNC Product will be realigned within this PE to AW-FY18-01 under a new Air Warfare R-2 Activity) - Initiate Single Platform Coherent Arrays - Develop and implement Electronic Warfare techniques and supporting technologies for intra-platform synchronized EW effects. (In FY19, this FNC Product will be realigned within this PE to AW-FY18-01 under a new Air Warfare R-2 Activity) ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	244.414	249.092	231.772	0.000	231.772

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	**Project (Number/Name)** 3346 / *Future Naval Capabilities Adv Tech Dev*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

As discussed in Section A, there are a significant number of FNC technology products within this PE. In all cases, these technology products support the Department of the Navy's FNC Program and are managed at the Office of Naval Research. All FNC investments in this PE are subjected to management oversight by 2-star chaired Integrated Product Teams (IPTs) that control the naval pillars of Sea Shield, Sea Strike, Sea Basing, Forcenet, Naval Expeditionary Maneuver Warfare, Enterprise and Platform Enablers, Power and Energy, Capable Manpower, and Force Health Protection. Each EC is aligned to a pillar and each technology product is aligned to an EC. At the lowest level, each technology product is measured against both technical and financial milestones on a monthly basis. Annually, each technology product is reviewed in depth for technical performance and development status by the Chief of Naval Research against goals that have been approved by the Navy's 3-star Technology Oversight Group (TOG). Also annually, each technology product is reviewed by its 2-star chaired pillar IPT for transition planning and adequacy and transition commitment level. Products must meet TOG required transition commitment levels for S&T development to continue. Transition issues and required adjustments are reported annually by the Chief of Naval Research to the TOG, which establishes investment priorities for the FNC Program.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603673N / *(U)Future Naval Capabilities Advanced Tech Dev*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	6.759	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.759

A. Mission Description and Budget Item Justification

The efforts described in this Project address the Advanced Technology Development associated with the Future Naval Capabilities (FNC) Program. The FNC Program represents the requirements-driven, delivery-oriented portion of the Navy's Science and Technology (S&T) portfolio. FNC investments respond to Naval S&T Gaps that are identified by the Navy and Marine Corps after receiving input from Naval Research Enterprise (NRE) stakeholders. The Enabling Capabilities (ECs) and associated technology product investments of the FNC Program are competitively selected by a 3-star Technology Oversight Group (TOG), chartered by the S&T Corporate Board and representing the requirements, acquisition, research and fleet/forces communities of the Navy and the Marine Corps.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: ASW Research Prog - Cong	6.759	0.000
FY 2016 Accomplishments: Expand field experimentation into new environments to further refine understanding of upper ocean acoustical phenomena for passive detection.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	6.759	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

In all cases, FNC technology products support the Department of the Navy's FNC Program and are managed at the Office of Naval Research. All FNC investments in this PE are subjected to management oversight by 2-star chaired Integrated Product Teams (IPTs). Each EC is aligned to a pillar and each technology product is aligned to an EC. At the lowest level, each technology product is measured against both technical and financial milestones on a monthly basis. Annually, each technology product is reviewed in depth for technical performance and development status by the Chief of Naval Research against goals that have been approved by the Navy's 3-star Technology Oversight Group (TOG). Also annually, each technology product is reviewed by its 2-star chaired pillar IPT for transition planning and adequacy and transition commitment level. Products must meet TOG required transition commitment levels for S&T development to continue. Transition issues and required adjustments are reported annually by the Chief of Naval Research to the TOG, which establishes investment priorities for the FNC Program.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603680N *I (U)Manufacturing Technology Program*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	54.739	56.712	57.797	-	57.797	58.832	60.706	60.711	61.925	Continuing	Continuing
1050: *Manufacturing Tech*	0.000	54.739	56.712	57.797	-	57.797	58.832	60.706	60.711	61.925	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Manufacturing Technology (ManTech) Program is intended to improve the productivity and responsiveness of the U.S. defense industrial base by funding the development, optimization, and transition of enabling manufacturing technologies to key naval suppliers. In general, investments transition emerging Science and Technology (S&T) results to acquisition programs; improve industrial capabilities in production, maintenance, repair and industrial base responsiveness; and advance manufacturing technology to reduce cost, improve performance, and responsiveness. Currently, the ManTech Program is focused on affordability improvements for specific key acquisition platforms as defined in the Navy ManTech Investment Strategy. Key platforms currently targeted include: VIRGINIA Class Submarine (VCS)/ OHIO Replacement Program (ORP); DDG 51 Class Destroyer; CVN 78 Class Carrier; Joint Strike Fighter (JSF); and CH-53K Heavy Lift Helicopter. ONR ManTech helps these Navy programs achieve their respective affordability goals by transitioning developed manufacturing technology which, when implemented, results in needed cost reduction or cost avoidance.

This Program Element, new as of FY16, is the result of the re-alignment of funds from PE 0708011N Industrial Preparedness and the Manufacturing Science and Technology activity from PE 0603758N Navy Warfighting Experiments and Demonstrations.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	57.074	56.712	57.797	-	57.797
Current President's Budget	54.739	56.712	57.797	-	57.797
Total Adjustments	-2.335	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.448	0.000			
• SBIR/STTR Transfer	-1.887	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603680N / *(U)Manufacturing Technology Program*	Project (Number/Name) 1050 / *Manufacturing Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
1050: *Manufacturing Tech*	0.000	54.739	56.712	57.797	-	57.797	58.832	60.706	60.711	61.925	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Manufacturing Technology (ManTech) Program is intended to improve the productivity and responsiveness of the U.S. defense industrial base by funding the development, optimization, and transition of enabling manufacturing technologies to key naval suppliers. In general, investments transition emerging Science and Technology (S&T) results to acquisition programs; improve industrial capabilities in production, maintenance, repair and industrial base responsiveness; and advance manufacturing technology to reduce cost, improve performance, and responsiveness. Currently, the ManTech Program is focused on affordability improvements for specific key acquisition platforms as defined in the Navy ManTech Investment Strategy. Key platforms currently targeted include: VIRGINIA Class Submarine (VCS)/ OHIO Replacement (OR); DDG 51 Class Destroyer; CVN 78 Class Carrier; Joint Strike Fighter (JSF); and CH-53K Heavy Lift Helicopter. ONR ManTech helps these Navy programs achieve their respective affordability goals by transitioning developed manufacturing technology which, when implemented, results in needed cost reduction or cost avoidance.

This Program Element, new as of FY16, is the result of the re-alignment of funds from PE 0708011N Industrial Preparedness and the Manufacturing Science and Technology activity from PE 0603758N Navy Warfighting Experiments and Demonstrations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Composites Processing and Fabrication	5.755	7.000	8.000	0.000	8.000
Description: The primary technical goal of the Composites Processing and Fabrication activity is improving weapon systems affordability, enhancing weapon system effectiveness and improving reliability/war-fighter readiness through the increased utilization of composite materials and structures. This is being achieved through the development, maturation, and transition of affordable and robust manufacturing, assembly, and repair processes that fully exploit the benefits of composite materials. Concentration is on affordability for the following platforms: VIRGINIA Class Submarine (VCS)/OHIO Replacement (ORP), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. The funding increase from FY16 to FY17 and FY17 to FY18 supports more composites focused work as the CH-53K project portfolio ramps up. ***FY 2016 Accomplishments:*** - Continued Composite Materials and Process Improvement Thrust for VCS/ORP Affordability Initiative. Includes efforts to develop/optimize composite materials fabrication technology for reduced cost VCS and ORP construction.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603680N / *(U)Manufacturing Technology Program*	**Project (Number/Name)** 1050 / *Manufacturing Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued Composite Materials and Process Improvement Thrust for DDG 51 Affordability Initiative. Includes efforts to develop/optimize composite materials fabrication technology for reduced cost DDG 51 construction. - Continued Composite Materials and Process Improvement Thrust for CVN 78 Affordability Initiative. Includes efforts to develop/optimize composite materials fabrication technology for reduced cost CVN 78 construction. - Continued Composite Materials and Process Improvement Thrust for JSF Affordability Initiative. Includes efforts to develop/optimize composite materials fabrication technology for reduced cost JSF construction. - Continued Composite Materials and Process Improvement Thrust for CH-53K Affordability Initiative. Includes efforts to develop/optimize composite materials fabrication technology for reduced cost CH-53K construction. - Continued Composite Materials and Process Improvement Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue composites processing and fabrication efforts of FY17. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy ***FY 2018 OCO Plans:*** N/A					
Title: Electronics Processing and Fabrication ***Description:*** The primary technical goal of the Electronics Processing and Fabrication activity is improving electronic weapon systems affordability by developing and transitioning affordable, robust manufacturing processes and capabilities for electronics critical to defense applications over their full life-cycle. Efforts create new and improved electronics/electro-optics manufacturing processes for transition to the production floor. Emphasis is on affordability for the following shipbuilding platforms: VIRGINIA Class Submarine (VCS)/OHIO Replacement (ORP), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. ***FY 2016 Accomplishments:*** - Continued Electronics/Electro-Optics Thrust for VCS/ORP Affordability Initiative. Includes efforts to improve electronics/electro-optics affordability for VCS and ORP construction. - Continued Electronics/Electro-Optics Thrust for DDG 51 Affordability Initiative. Includes efforts to improve electronics/electro-optics affordability for DDG 51 construction.	11.030	12.000	12.000	0.000	12.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603680N / *(U)Manufacturing Technology Program*	**Project (Number/Name)** 1050 / *Manufacturing Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued Electronics/Electro-Optics Thrust for CVN 78 Affordability Initiative. Includes efforts to improve electronics/electro-optics affordability for CVN 78 construction. - Continued Electronics/Electro-Optics Thrust for JSF Affordability Initiative. Includes efforts to improve electronics/electro-optics affordability for JSF construction. - Continued Electronics/Electro-Optics Thrust for CH-53K Affordability Initiative. Includes efforts to improve electronics/electro-optics affordability for CH-53K construction. - Continued Electronics/Electro-Optics Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue electronics processing and fabrication efforts of FY17. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2018 OCO Plans:*** N/A					
Title: Metals Processing and Fabrication ***Description:*** The primary technical goal of the Metals Processing and Fabrication activity is to develop affordable, robust manufacturing and repair processes/capabilities for metals and special materials critical to Navy weapon system applications. Major areas that support this objective include: processing methods, special materials, joining, machining, coating/cladding, assembly, and inspection and compliance resulting in reduced cost of fabrication for components. Emphasis is on affordability for the following platforms: VIRGINIA Class Submarine (VCS)/OHIO Replacement (OR), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. This activity also includes the development, optimization, and transition of repair technology for the repair, overhaul, and sustainment of key navy systems. The funding decreases from FY16 to FY17 and FY 17 to FY18 reflect an investment strategy shift from primarily supporting ship platforms to more balance with JSF and CH-53K and subsequently more focus on the Composites, Electronics and Manufacturing Enterprise/Other technical areas. ***FY 2016 Accomplishments:***	14.866	12.800	12.000	0.000	12.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603680N / *(U)Manufacturing Technology Program*	**Project (Number/Name)** 1050 / *Manufacturing Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued Metals Processing Thrust for VCS/OR Affordability Initiative. Includes efforts to improve affordability for VCS and OR construction. - Continued Metals Processing Thrust for DDG 51 Affordability Initiative. Includes efforts to improve affordability for DDG 51 construction. - Continued Metals Processing Thrust for CVN 78 Affordability Initiative. Includes efforts to improve affordability for CVN 78 construction. - Continued Metals Processing Thrust for JSF Affordability Initiative. Includes efforts to improve affordability for JSF construction. - Continued Metals Processing Thrust for CH-53K Affordability Initiative. Includes efforts to improve affordability for CH-53K construction. - Continued Metals Processing Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. - Continued Repair Technology (RepTech) Thrust to develop, optimize, and transition repair technology for key naval platforms at depots and logistics centers. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:*** Continue metals processing and fabrication efforts of FY17. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2018 OCO Plans:*** N/A					
Title: Manufacturing Enterprise/Other ***Description:*** The Manufacturing Enterprise / Other activity includes: (1) efforts targeted towards improving, in general, the manufacturing enterprise for the production of key naval platforms (both shipbuilding and aircraft), (2) energetic efforts, (3) naval research enterprise and laboratory support for key projects, and (4) technical program support. Manufacturing Enterprise addresses the development, optimization, and transition of manufacturing enterprise technology to key naval platform suppliers. Emphasis is on affordability for the following shipbuilding platforms: VIRGINIA Class Submarine (VCS)/OHIO Replacement (ORP), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. Manufacturing enterprise technology areas include, but are not limited to Design for Producibility/Design for Manufacturability; development of build/assembly strategies; modeling and simulation technologies; model-based tools and	23.088	24.912	25.797	0.000	25.797

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603680N / *(U)Manufacturing Technology Program*	**Project (Number/Name)** 1050 / *Manufacturing Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
approaches to optimize producibility; intelligent manufacturing planning and factory execution; elimination of inefficiencies in design optimization, material usage, labor utilization, work flow, etc.; supply chain procedures and improvements (such as network centric manufacturing capabilities to facilitate resilient and adaptable supply chains); development of more efficient structural fabrication product lines; and inspection technologies. Energetics efforts concentrate on developing energetics solutions to ensure the availability of safe, affordable, and quality energetics products largely in support of Program Executive Office (PEO) Integrated Warfare Systems (IWS). The funding increase from FY16 to FY17 is due to an investment strategy shift from primarily supporting ship platforms to more balance with JSF and CH-53K and subsequently more focus on the Manufacturing Enterprise/ Other technical area. ***FY 2016 Accomplishments:*** - Continue Manufacturing Enterprise Thrust for VCS/ORP Affordability Initiative. Includes efforts to improve affordability for VCS and ORP construction. - Continue Manufacturing Enterprise Thrust for DDG 51 Affordability Initiative. Includes efforts to improve affordability for DDG 51 construction. - Continue Manufacturing Enterprise Thrust for CVN 78 Affordability Initiative. Includes efforts to improve affordability for CVN 78 construction. - Continue Manufacturing Enterprise Thrust for JSF Affordability Initiative. Includes efforts to improve affordability for JSF construction. - Continue Manufacturing Enterprise Thrust for CH-53K Affordability Initiative. Includes efforts to improve affordability for CH-53K construction. - Continue Manufacturing Enterprise Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. - Continue Energetics Thrust for PEO IWS and Other Acquisition Programs. Includes energetics efforts to support PEO IWS and other acquisition programs. - Continue efforts to provide naval research enterprise and laboratory support for key projects. - Continue efforts to provide technical engineering support for the ManTech Program. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. ***FY 2018 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603680N / *(U)Manufacturing Technology Program*	**Project (Number/Name)** 1050 / *Manufacturing Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue manufacturing enterprise/other processing and fabrication efforts of FY17. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	54.739	56.712	57.797	0.000	57.797

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Efforts are focused on affordability improvements (both acquisition and life-cycle) for specific key acquisition platforms as defined in the Navy ManTech Investment Strategy. Currently, the majority of Navy ManTech efforts are focused on affordability improvements for: VIRGINIA Class Submarine (VCS)/OHIO Replacement (OR), DDG-51 Class Destroyer, CVN-78 Class Carrier, Joint Strike Fighter (JSF), and CH-53-K Heavy Lift Helicopter.

E. Performance Metrics

The ManTech Program's overall goal is to transition production technology to reduce the cost of Navy weapon systems. Metrics are currently collected on the cost savings per hull or per aircraft for each of the primary affordability platforms: VIRGINIA Class Submarine/OHIO Replacement (VCS/OR), DDG-51 Class Destroyer, CVN-78 Class Carrier, Joint Strike Fighter (JSF), and CH-53-K Heavy Lift Helicopter.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603729N *I Warfighter Protection Adv Tech*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	34.894	4.789	4.878	-	4.878	4.877	4.878	4.879	4.977	Continuing	Continuing
2914: *Warfighter Protection Adv Tech*	0.000	4.481	4.789	4.878	-	4.878	4.877	4.878	4.879	4.977	Continuing	Continuing
9999: *Congressional Adds*	0.000	30.413	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.413

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This program supports the development and demonstration of field medical equipment and technologies to improve warfighter safety and to enhance personnel performance under adverse conditions. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	36.299	4.789	4.878	-	4.878
Current President's Budget	34.894	4.789	4.878	-	4.878
Total Adjustments	-1.405	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.206	0.000			
• SBIR/STTR Transfer	-1.198	0.000			
• Rate/Misc Adjustments	-0.001	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603729N *I Warfighter Protection Adv Tech*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *CW Bill Young Marrow Donor Program*	30.413	0.000
Congressional Add Subtotals for Project: 9999	30.413	0.000
Congressional Add Totals for all Projects	30.413	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603729N / *Warfighter Protection Adv Tech*	Project (Number/Name) 2914 / *Warfighter Protection Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2914: *Warfighter Protection Adv Tech*	0.000	4.481	4.789	4.878	-	4.878	4.877	4.878	4.879	4.977	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program supports the development and demonstration of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The National Institutes for Health (NIH) focuses on the basic science of disease processes and not product development. Programs are coordinated with other Services through the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee to prevent duplication of effort.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: NAVAL NOISE-INDUCED HEARING LOSS (NIHL)	4.481	4.789	4.878	0.000	4.878
Description: The goal of this program is to reduce the incidence of NIHL by nearly 100%. This program employs a total systems engineering approach that includes advancements in medical technology, jet engine physics, personal protective equipment, and mitigation analyses.					
FY 2016 Accomplishments: NOISE INDUCED HEARING LOSS - Continued advanced research in medical prevention and treatment of NIHL and tinnitus (ringing in the ears). - Continued advanced research to reduce noise at the source, jet engine quieting and flight deck noise reduction. - Continued advanced research to improve personal protective equipment technology. - Continued advanced research to study the incidence and susceptibility of NIHL and tinnitus, and to evaluate mitigation strategies. REGENERATIVE MEDICINE - Continued program with Army, in regenerative medicine (Armed Forces Institute of Regenerative Medicine (AFIRM II).					
FY 2017 Plans: - Continue all efforts of FY 2016.					
FY 2018 Base Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603729N / *Warfighter Protection Adv Tech*	**Project (Number/Name)** 2914 / *Warfighter Protection Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
NOISE INDUCED HEARING LOSS Conduct advanced research in medical prevention and treatment of NIHL and tinnitus. Investigate the incidence and susceptibility of NIHL and tinnitus, and evaluate mitigation strategies. Study the reduction of noise at the source, jet engine quieting and flight deck noise reduction and improve personal protective equipment technology. REGENERATIVE MEDICINE Conduct advanced research in regenerative medicine with the Armed Forces Institute of Regenerative Medicine (AFIRM). ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	4.481	4.789	4.878	0.000	4.878

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Efforts within this PE are measured at two levels. At the lower level, each is measured against technical and financial milestones on a monthly basis. Annually, each project is reviewed in depth for technical and transition performance by the Chief of Naval Research (CNR).

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603729N / *Warfighter Protection Adv Tech*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	30.413	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.413

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: CW Bill Young Marrow Donor Program	30.413	0.000
FY 2016 Accomplishments: National Marrow Donor Program (NMDP) will continue to expand participation of transplant centers increasing the enrollment of volunteer donors to the national registry. Hospitals that participate in both the NMDP Network of treatment centers as well as the NDMS managed by the Department of Health and Human Services. Scientific Advances: Continue improvements in accuracy of the NMDP scientific and clinical matching system, Haplogic III and linked to the NMDP clinical data system (Phoenix). ***FY 2017 Plans:*** N/A		
Congressional Adds Subtotals	30.413	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Congressional Interest Items not included in other Projects.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy												Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603747N *I Undersea Warfare Advanced Tech*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	13.251	25.880	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.131
2916: *Undersea Warfare Advanced Technology*	0.000	13.251	25.880	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.131

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this PE. The related technologies being developed are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new Anti-Submarine Warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. The focus is on leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship and air ASW assets.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	13.748	25.880	39.877	-	39.877
Current President's Budget	13.251	25.880	0.000	-	0.000
Total Adjustments	-0.497	0.000	-39.877	-	-39.877
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.497	0.000			
• Program Adjustments	0.000	0.000	-39.877	-	-39.877
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603747N *I Undersea Warfare Advanced Tech*

Change Summary Explanation

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the Large Displacement UUV INP Program and the ASW Mission Package program to the new PE 0603801N Innovative Naval Prototypes Advanced Technology Development.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603747N / *Undersea Warfare Advanced Tech*	Project (Number/Name) 2916 / *Undersea Warfare Advanced Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2916: *Undersea Warfare Advanced Technology*	0.000	13.251	25.880	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.131

A. Mission Description and Budget Item Justification

All Navy advanced technology developments in undersea target detection, classification, localization, tracking and neutralization are funded through this project. Technologies being developed within this project are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new ASW operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship and air ASW assets.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Naval Forces UUV Development	13.251	25.880	0.000	0.000	0.000

Description: Develop critical technology for Long Endurance LDUUV to meet 30+ days. Critical technology includes Energy, Autonomy, and Endurance. Innovative Naval Prototype (INP) - Large Displacement UUV (LDUUV)

Funding increase for FY 2016 to FY 2017 is due to increase development of technologies for a longer range LDUUV. Leverages endurance technologies developed under PE 0602747N with continue development. Increase AT SEA TESTING to mature technologies to increase LD-UUV technology range.

The funding decrease from FY 2017 to FY 2018 reflects the realignment of the Large Displacement UUV INP Program and the ASW Mission Package program to the new PE 0603801N Innovative Naval Prototypes Advanced Technology Development.

FY 2016 Accomplishments:
- Continued all efforts from FY 2015, less those noted as completed above.
- Initiated Select UUV for ASW mission and measure it's characteristics.
- Initiated design and construction at sea test article for Virtual Acoustic Senor Array.

FY 2017 Plans:
- Continue all efforts of FY 2016, less those noted as completed above.
- Complete design and construction at sea test article for Virtual Acoustic Sensor Array.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603747N / *Undersea Warfare Advanced Tech*	**Project (Number/Name)** 2916 / *Undersea Warfare Advanced Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate at sea tests of the Virtual Acoustic Sensor Array ***FY 2018 Base Plans:*** Large Displacement UUV INP Program realigned to new Innovative Naval Prototype (INP) PE 0603801N. ASW Mission Package program INP realigned to new Innovative Naval Prototype (INP) PE 0603801N. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	13.251	25.880	0.000	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Improve target detection, localization, and tracking and increase attack capabilities by providing the following capabilities:
- Localization of 85% or more of enemy submarines in far forward or contested waters with false locations of less than 10% of total calls.
- Effective cueing of an attack from a distance of up to 200nm.
- Improvement of the Lightweight Torpedo (Mk 54). Specific improvements are classified.
- Extending deep water active distributed system lifetime to a few months with a probability of detection (Pd) of 90% within 4 hours (field configuration) or 90% per crossing (barrier configuration), with a False Alarm Rate (FAR) of no more than 4/day.
- Delivery from a Vertical Takeoff Unmanned Air Vehicle (VTUAV) and/or a long-range, high-speed Unmanned Air Vehicle (UAV) a compact undersea weapon capable of a high Probability of Kill (PK) given precise target localization.
- Detection and localization performance with a single-line vector sensor array nominally equivalent or superior to that of two coherently processed TB-29A arrays. Acquisition costs to be competitive with the cost of a current TB-29A and at least 30% less than the cost of two arrays. Sensor and telemetry packaging will be adequate to achieve neutral buoyancy in an existing TB-29A form factor with array power efficiency greater than 75%. Array handling will be compatible with the existing TB-29 handling system.

Increase sensor to shooter performance and the effective lifetime of distributed ASW search systems by:
- Achieving a drifting active distributed system lifetime of at least two days in areas of tactical significance while maintaining required system performance with a minimum number of sensor nodes.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603747N / *Undersea Warfare Advanced Tech*	**Project (Number/Name)** 2916 / *Undersea Warfare Advanced Technology*

- Maintaining an effective lifetime of a month for mobile active distributed systems when subjected to the action of eddies from a major ocean current.
- Predicting reseed 6 hours before performance degrades.
- Holding the Area of Uncertainty (AOU) to no larger than 10 nm2 for an hour after initial detection through the control of the coherent sources.

Through a combination of better Anti-Submarine Warfare (ASW) command-level training and improved operator training provide the following:
- Improve the ability of active sonar operators to detect targets and reject potential false alarms compared to current simulation based training.
- Increase Pd by 50%.
- Provide a decrease in FAR by a factor of two.
- Provide a reduction in the probability of a hit on a High Value Unit (HVU) by a factor of two.
- Improve the ability of the ASW Commander to position assets to increase coverage, reduce active system interference and deal effectively with competing missions.
- Reduce training cost by greater than 80% and increase the frequency of training opportunities by greater than 600% relative to live training.

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603758N *I Navy Warfighting Exp & Demo*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	65.553	60.550	64.889	-	64.889	68.128	108.737	142.340	123.516	Continuing	Continuing
2918: *Navy Warfighting Experiments and Demo*	0.000	65.553	60.550	64.889	-	64.889	68.128	108.737	142.340	123.516	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Program Element (PE) addresses the development of recent technology breakthroughs to meet current operational needs from a subscale proof-of-principle into a full-scale prototype for warfighter experimentation during laboratory and operational demonstrations, Fleet Battle Experiments (FBE), Limited Objective Experiments (LOEs) and sea trial exercises. The key aspects of this PE are divided into four areas: (1) SwampWorks develops and demonstrates newly invented or recently discovered technologies that address emergent and enduring operational problems in an accelerated timeframe; (2) ONR Experimentation (OE) develops rapid prototypes and provides them to the warfighter for experimentation during laboratory and operational demonstrations; (3) TechSolutions develops rapid response science and technology prototypes addressing Fleet/Force needs identified by Sailors and Marines at the deckplate level; (4) Operations Analysis provides the Navy and Marine Corps the means to identify capability needs that can be addressed with science and technology solutions; and (5) support for the Naval Precision Strike Operations, providing the Navy capability to quickly locate, target, and strike critical targets.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

FY 2016 included a single year investment for the research in Directed Energy (Solid State Laser - Technology Maturation or SSL-TM) which explains the funding decrease from FY 2016 to FY 2017. A new activity was moved into this PE in 2018 - Precision Strike Technology, formerly funded in PE 0603114N Power Projection Advanced Technology.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	65.946	60.550	84.122	-	84.122
Current President's Budget	65.553	60.550	64.889	-	64.889
Total Adjustments	-0.393	0.000	-19.233	-	-19.233
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.689	0.000			
• SBIR/STTR Transfer	-1.082	0.000			
• Program Adjustments	0.000	0.000	-19.233	-	-19.233
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603758N *I Navy Warfighting Exp & Demo*

Change Summary Explanation

The FY 2018 funding decrease reflects the realignment of funding to PE 0603801N Innovative Naval Prototypes.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603758N / *Navy Warfighting Exp & Demo*	Project (Number/Name) 2918 / *Navy Warfighting Experiments and Demo*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2918: *Navy Warfighting Experiments and Demo*	0.000	65.553	60.550	64.889	-	64.889	68.128	108.737	142.340	123.516	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on the development of recent technology breakthroughs to meet current operational needs from a subscale proof-of-principle into a full-scale prototype for warfighter experimentation during laboratory and operational demonstrations, Fleet Battle Experiments (FBEs), Limited Objective Experiments (LOEs) and sea trial exercises.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: NAVAL WARFARE EXPERIMENTATION	21.548	22.352	18.731	0.000	18.731

Description: The objective of this project is to capitalize on recent technology breakthroughs to develop and integrate components including subsystems into prototypes quickly. These technologies are provided to the warfighter for experimentation, field experiments, and/or tests in simulated or actual environments. The use of Navy Warfare Development Command (NWDC) Fleet Experimentation (FLEX) events is encouraged and the net results are to gain the knowledge that only an experiment can provide.

Increase in FY 2017 will support emergent opportunities to meet fleet needs with advanced technologies including demonstrations and experimentation with Electronic Warfare, Undersea Maneuver Warfare and Advanced Autonomy technologies.

Decrease from FY 2017 to FY 2018 is due to completion of increased products in the areas of Autonomy, Electromagnetic Warfare and the exploitation of unmanned systems. Funding is back to expected level.

FY 2016 Accomplishments:
- Demonstrated unmanned air vehicle swarming technologies in collaboration with the warfighter, laboratories and operational forces.
- Demonstrated USV SWARM technologies.

FY 2017 Plans:
- Continue all efforts of FY 2016. Examples include:
- Electromagnetic Warfare: 360 Degree View CVN Protection
- Undersea Maneuver Warfare: Bow planes, Undersea Contactless Power & Communications Connector

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603758N / *Navy Warfighting Exp & Demo*	**Project (Number/Name)** 2918 / *Navy Warfighting Experiments and Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate new experimentation initiatives to support high impact fleet efforts. Examples include: - Electromagnetic Warfare: Ship Emissions Assessment (SEA) Drone, Open Tactical Router, DASH-X EW Netted Sensors - Advanced Autonomy: Cross-USV stero (CUS) Follow On experimentation in support of USV SWARM. Follow on from an "Operations Analysis" study performed in FY16. - Leverage fleet experimentation venues in order to optimize development efforts and gain greater fleet/force feedback of developing technologies. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017. - Initiate efforts to address the priorities of the Chief of Naval Research and the Chief of Naval Operations ***FY 2018 OCO Plans:*** N/A					
Title: OPERATIONS ANALYSIS	2.164	3.112	2.017	0.000	2.017
Description: The objective of this project is to provide operational analysis through studies, analyses, gaming and experimentation to identify Navy and Marine Corps capability needs that can be addressed with S&T solutions. The effort includes core analysis of S&T programs, military utility/capability gaps analyses, war gaming, structured experimentation events, the articulation of the results of that analysis and wargaming, and the development of innovation strategies and messages resulting from these analyses. Recent work includes participation in SIMulation EXercise (SIMEX) design, data collection and analysis events; wargame design in support of the ONR Office of Technology; analytical, strategic planning, and wargaming support; organizing and conducting workshops and symposia that increase innovation outreach; and participating in Red Teaming and conceptual analysis. ***FY 2016 Accomplishments:*** - Conducted a wargame to identify capability needs for the medium displacement unmanned surface vehicle, utilize operational personnel to ensure S&T solutions are focused on capabilities needed for unmanned systems. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. - Initiate efforts in support of Fleet/Force. ***FY 2018 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603758N / *Navy Warfighting Exp & Demo*	**Project (Number/Name)** 2918 / *Navy Warfighting Experiments and Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue all efforts of FY 2017. Conduct Wargames, Technology Innovation Games and technology analysis efforts to inform S&T initiatives. ***FY 2018 OCO Plans:*** N/A					
Title: SWAMPWORKS	31.890	25.086	22.563	0.000	22.563
Description: SwampWorks seeks to develop and demonstrate technologies that address emergent and enduring operational problems in an accelerated timeframe. The general nature of these efforts are high risk/high reward and constitute a leap ahead in capability or technology. Some of these technologies may become part of a follow-on technology development, may end up in the hands of the warfighter for Fleet/Force experimentation, or may culminate in a significant Fleet/Force exercise that demonstrates capability then transitions into the Acquisition Program of Record (POR). FY 2016 included a single year investment for the research in Directed Energy (Solid State Laser - Technology Maturation or SSL-TM) which explains the funding decrease from FY 2016 to FY 2017. The funding decrease from FY 2017 to FY 2018 is reflects fewer products in unmanned systems. ***FY 2016 Accomplishments:*** - Initiated additional projects in the area of Autonomy, Electromagnetic Warfare and exploitation of unmanned systems. - Pursued emergent technology opportunities to support high impact Pacific pivot efforts. ***FY 2017 Plans:*** - Continue all efforts of FY 2016. - FY 2017 technology efforts include: - Personal Assistant for Life Long Learning (PAL3) with ARO. - SPY 1 multiple-beam klystrons (MBK) with NRL. - Very Short Pulse Laser with NRL. - Universal Repeatable-Release Holdback Bar with NAWC Lakehurst. - Monitoring Osseo Integrated Prostheses (MOIP) with NRL. - Coordinated Ionospheric Reconstruction Cubesat Experiment (CIRCE) with NRL. - Large Scale AM with NSWC Carderock.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603758N / *Navy Warfighting Exp & Demo*	**Project (Number/Name)** 2918 / *Navy Warfighting Experiments and Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- LC-SAS on XLUUV with NSWC Panama City. ***FY 2018 Base Plans:*** - Continue all efforts of FY 2017. - Initiate projects in response to the Chief of Naval Research and the Chief of Naval Operations priorities as well as technologies of interest for the Pacific Area of Responsibility (AOR). - Under the leadership of the Director of Research at ONR, the SwampWorks portfolio explores high-risk, disruptive, and innovative technologies and concepts, and provides a venue to develop innovative technologies. All SwampWorks activities are targeted towards advancing the capabilities of naval warfighters. Because of the portfolio's high-risk nature, brief exploratory studies can be performed to examine the maturation of the technology proposed before making substantial investments. The SwampWorks program has substantial flexibility in planning and execution which includes a streamlined approval process to allow for the shortest possible technology development timeframe. The balance of the S&T projects that will start in FY18 will be identified during FY18 as the needs of the warfighters, for investments in this portfolio, evolve or change. SwampWorks is not limited to any set of technology areas. The portfolio is open to great ideas all year long and invests in innovative technology development that will ultimately provide a dramatic improvement for the warfighter. ***FY 2018 OCO Plans:*** N/A					
Title: TECH SOLUTIONS ***Description:*** TechSolutions develops rapid response Science and Technology (S&T) solutions to immediate Fleet/Force needs identified by individual warfighters at the deckplate level. Sailors, Marines and Science Advisors submit their issues throughout the year via the TechSolutions website, email, phone, or chain of command. Projects are initiated as requests are received and are completed in approximately twelve to eighteen months, resulting in a prototype demonstration of Technology Readiness Level (TRL) 6 or higher. ***FY 2016 Accomplishments:*** - Continued development of projects that will provide solutions to address emergent critical needs. - Developed, demonstrated and delivered technical solution prototypes to projects initiated in the previous fiscal year. ***FY 2017 Plans:*** - Continue all efforts of FY 2016.	9.951	10.000	9.186	0.000	9.186

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603758N / *Navy Warfighting Exp & Demo*	**Project (Number/Name)** 2918 / *Navy Warfighting Experiments and Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate rapid response S&T projects in direct support of Fleet/Force needs. ***FY 2018 Base Plans:*** Continue all efforts of FY 2017. Initiate efforts based on Fleet/Force interactions and warfighter needs. ***FY 2018 OCO Plans:*** N/A					
Title: PRECISION STRIKE TECHNOLOGY ***Description:*** The efforts described in this Activity are based on investment directions as defined in the Naval S&T Strategic Plan approved by the Science & Technology Corporate Board of 20 January 2015. This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. Prior to 2018, this effort was funded in PE 0603114N. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** Efforts in this area support Naval Precision Strike Operations, providing the Navy capability to quickly locate, target, and strike critical targets. Prior to FY 2018, this effort was funded in PE 0603114N Power Projection Advanced Technology Development ***FY 2018 OCO Plans:*** N/A	0.000	0.000	12.392	0.000	12.392
Accomplishments/Planned Programs Subtotals	65.553	60.550	64.889	0.000	64.889

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603758N / *Navy Warfighting Exp & Demo*	**Project (Number/Name)** 2918 / *Navy Warfighting Experiments and Demo*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Overall metric goals are to transition the 6.3 advanced technology projects into acquisition programs of record, demonstrate successful technologies to enable new operational concepts, and enable the production of technology products such as proofs of concept and manufacturing packages. The performance of the work funded in this PE is reviewed at several levels to ensure that the investment is relevant and productive. At the macroscopic level, the investment is coordinated with Navy Warfare Development Command and Commander, Fleet Forces Command to address the goals and objectives identified for sea trials and Limited Objective Experiments (LOEs). At the microscopic level, the work funded in this PE is reviewed periodically by the Program Manager to ensure the investment is meeting the goals defined for each project. This review includes feedback collected from the warfighter community on all sea trials and LOEs to support the Program Manager's assessment of the value and relevance of each investment. Furthermore, the entire program is reviewed yearly by the Chief of Naval Research.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	3.349	15.167	15.164	-	15.164	13.172	13.415	1.959	1.998	Continuing	Continuing
2917: *Shallow Water MCM Demos*	0.000	1.901	15.167	15.164	-	15.164	13.172	13.415	1.959	1.998	Continuing	Continuing
9999: *Congressional Adds*	0.000	1.448	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.448

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015) and investment directions as defined by Department of Defense (DoD) Directive 5160.62 "Single Manager Responsibility for Military Explosive Ordnance Disposal Technology and Training (EODT&T)" and approved by the DoD Explosive Ordnance Disposal (EOD) Program Board (Sep 2012). This strategy is based on needs and capabilities from Navy and Marine Corps guidance, input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). The strategy is also based on the unique needs and capabilities identified by the Joint Requirements Oversight Council (JROC) and the DoD EOD Program Board. It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval and Joint EOD forces in the 21st century. The strategy focuses and aligns Naval S&T with Naval missions, DoD EOD S&T with Joint EOD missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE primarily develops and demonstrates prototype Mine Countermeasures (MCM), Expeditionary Warfare and Joint EOD system components that support capabilities enabling Naval and Joint EOD Forces to influence operations ashore. Adversarial nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littorals. They also have the capability to develop or modify explosive devices such as mines and unexploded ordnance to construct Improvised Explosive Devices (IEDs) for the purpose of targeting Joint Forces. Real world operations have demonstrated the requirement to quickly counter the mine threat. Current operations have also demonstrated the requirement to quickly counter the threat from explosive hazards and IEDs during DoD operations. Advanced technologies must rapidly detect and neutralize all mine types, from deep water to the inland objective. Advanced technologies must enable Joint EOD forces to detect/locate, gain access, diagnose, render safe, neutralize, recover, exploit and dispose of a broad spectrum of explosive hazards including unexploded ordnance and IEDs. This program supports the advanced development and integration of sensors, processing, warheads, and delivery vehicles to demonstrate improved Naval Warfare capabilities. It supports the advanced development and integration of sensors and tools for standoff capabilities such as detection and location of IEDs (particularly in dismounted operations), dismounted diagnosis of buried munitions and other explosive hazards, precision render safe and neutralization of surface munitions and other explosive hazards, and enhanced access to IEDs. It supports the MCM-related FNC Enabling Capabilities (ECs). Within the Naval Transformation Roadmap, this investment will achieve one of three key transformational capabilities required by Sea Shield as well as technically enable the Ship To Objective Maneuver (STOM) key transformational capability within Sea Strike.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	3.491	15.167	15.470	-	15.470
Current President's Budget	3.349	15.167	15.164	-	15.164
Total Adjustments	-0.142	0.000	-0.306	-	-0.306
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.047	0.000			
• SBIR/STTR Transfer	-0.095	0.000			
• Program Adjustments	0.000	0.000	-0.306	-	-0.306
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	1.448	0.000
Congressional Add Subtotals for Project: 9999	1.448	0.000
Congressional Add Totals for all Projects	1.448	0.000

Change Summary Explanation

The increase in FY 2017 is due to the transfer of research efforts and activities previously conducted in the Advanced Sea Mines Future Naval Capability (FNC) effort (SHD-FY16-OSD Modular Undersea Effectors (MUSE)) from PE 0603673N Future Naval Capabilities Advanced Technology Development to PE 0603782N Mine and Expeditionary Warfare Advanced Technology.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	Project (Number/Name) 2917 / *Shallow Water MCM Demos*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
2917: *Shallow Water MCM Demos*	0.000	1.901	15.167	15.164	-	15.164	13.172	13.415	1.959	1.998	Continuing	Continuing

A. Mission Description and Budget Item Justification

This PE develops and demonstrates prototype technology for Mine Countermeasures (MCM), US Naval sea mining, and Expeditionary Warfare and Joint EOD system components that support capabilities enabling Naval and Joint EOD Forces to influence operations ashore. Adversarial nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littorals. They also have the capability to develop or modify explosive devices such as mines and unexploded ordnance to construct Improvised Explosive Devices (IEDs) for the purpose of targeting Joint Forces. Real world operations have demonstrated the requirement to quickly counter the mine threat. Current operations have also demonstrated the requirement to quickly counter the threat from explosive hazards and IEDs during DoD operations. Advanced technologies must rapidly detect and neutralize all mine types, from deep water to the inland objective. Advanced technologies must enable Joint EOD forces to detect/locate, gain access, diagnose, render safe, neutralize, recover, exploit and dispose of a broad spectrum of explosive hazards including unexploded ordnance and IEDs. This program supports the advanced development and integration of sensors, processing, warheads, and delivery vehicles to demonstrate improved Naval Warfare capabilities. It supports the advanced development and integration of sensors and tools for standoff capabilities such as detection and location of IEDs (particularly in dismounted operations), dismounted diagnosis of buried munitions and other explosive hazards, precision render safe and neutralization of surface munitions and other explosive hazards, and enhanced access to IEDs. It supports advanced development for battlespace shaping weapons including advanced undersea weapons. It supports the MCM related FNC Enabling Capabilities (ECs). Within the Naval Transformation Roadmap, this investment will achieve one of three key transformational capabilities required by Sea Shield as well as technically enable the Ship To Objective Maneuver (STOM) key transformational capability within Sea Strike.

The increase in FY 2017 is due to the transfer of research efforts and activities previously conducted in the Advanced Sea Mines Future Naval Capability (FNC) effort (SHD-FY16-OSD Modular Undersea Effectors (MUSE)) from PE 0603673N Future Naval Capabilities Advanced Technology Development to PE 0603782N Mine and Expeditionary Warfare Advanced Technology.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Joint EOD Demos	1.901	1.957	1.958	0.000	1.958
Description: This activity focuses on developing and demonstrating technologies to support a standoff or remote capability for detection and location, diagnosis, render safe, neutralization and enhanced access. Efforts include: electromagnetic, electro-optical, and acoustic sensors and systems for detection of explosive threat components including explosives, device housings/containers, and triggering mechanisms, standoff identification and confirmation of trace explosives, fusion of multi-sensor input for high confidence detection and diagnosis of buried threats, highly dexterous manipulators and imitative controllers for lightweight, efficient (strength/weight ratio) dual manipulator systems integrated onto EOD robots for enhanced access, enhanced robotic autonomy					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 / *Shallow Water MCM Demos*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total

to support EOD missions, data compression and visualization techniques to support precise render safe and neutralization, and neutralization devices containing reactive materials to neutralize devices with low collateral damage.

This S&T investment supports the Joint Requirements Oversight Council (JROC) and DoD EOD Program Board validated requirements for Joint EOD missions. This S&T investment provides critical S&T transitions to acquisition programs. This investment in Joint EOD S&T is reported annually to the DoD EOD Program Board. This S&T investment is documented in the DoD EOD Applied Research Program Plan which is reviewed and approved annually by the DoD EOD Program Board.

FY 2016 Accomplishments:
- Continued development of a laser interferometric sensor/system that can be integrated onto various platforms including EOD robots for detection and/or diagnosis of buried objects.
- Continued development of highly dexterous dual manipulator systems (manipulators, controllers) that can be integrated onto EOD robots for precision render safe and neutralization missions.
- Continued development of a Resonance Raman (single or dual wavelength) detector for standoff detection of trace explosives that can be integrated into a handheld device or onto an EOD robot.
- Initiated development of sensors that can be integrated into a handheld device or onto an EOD robot to detect deeply buried objects.
- Initiated development of excavation tools and techniques that can be integrated into a handheld device or onto an EOD robot for precision recovery and diagnosis of buried objects.
- Initiated development of neutralization tools and technigues that can be deployed by an EOD technician or integrated onto an EOD robot for effective target neutralization with low collateral damage to surrounding infrastructure.

FY 2017 Plans:
- Continue all efforts of FY 2016 less those noted as completed above.
- Initiate development of a robotic system demonstrator for stand-off detection of trace and bulk explosive materials.
- Initiate development of a robotic system demonstrator for autonomous grasping and manipulation.

FY 2018 Base Plans:
Conduct advanced technology development and demonstration in electro-optic & acoustic technologies for buried mine detection, robotic manipulation for ordnance exploitation & neutralization, standoff detection

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 / *Shallow Water MCM Demos*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
and classification for ordnance, and identification of explosives. Efforts in this thrust include prototype and demonstration of laser interferometric sensor / systems for detection of buried objects, highly dexterous dual manipulator systems (manipulators, controllers) for EOD robots for precision render safe and neutralization missions, Resonance Raman (single or dual wavelength) detector for standoff detection, and excavation tools and techniques for precision recovery and diagnosis of buried objects. ***FY 2018 OCO Plans:*** N/A					
Title: Mine Technology ***Description:*** This activity focuses on developing and demonstrating technology to support on-demand battlespace shaping through advanced undersea weapons. Efforts include command & control (C2), remote control, advanced sensing technologies, compatibility with unmanned delivery options, detection & classification, and targeting solutions. The program, Modular Undersea Effector System (MUSE), is a limited duration effort for advanced mining and responds to recent request for capability from the fleet. The increase in FY 2017 is due to the transfer of research efforts and activities previously conducted in the Advanced Sea Mines Future Naval Capability (FNC) effort (SHD-FY16-OSD Modular Undersea Effectors (MUSE)) from PE 0603673N Future Naval Capabilities Advanced Technology Development to PE 0603782N Mine and Expeditionary Warfare Advanced Technology for further technology maturation. The transfer was made to better align the research within the current DoN RDT&E program structure. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** - Initiate development of advanced sensing technologies - Initiate development of command & control and advanced detection & classification technologies ***FY 2018 Base Plans:*** Conduct advanced technology development and demonstration in advanced mining concepts including remote control, advanced sensing, command & control (C2), and more discriminative targeting solutions. Efforts in this	0.000	13.210	13.206	0.000	13.206

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 / *Shallow Water MCM Demos*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
thrust include prototyping advanced sensors and sensor configuration technologies for improved discrimination as well as communications, command, and control technologies. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	1.901	15.167	15.164	0.000	15.164

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of this advanced technology program are the development of technologies supporting the Mine and Expeditionary Warfare challenges of reducing the MCM tactical timeline from months to days and eliminating the need for Navy divers and manned equipment to enter minefields. Another important metric is the scheduled transition of 6.3 advanced technology projects from the FNCs program into Navy and Marine Corps acquisition programs at agreed upon Technology Readiness Levels. Technology-specific metrics include: Mine warfare data fusion capabilities yielding a 10%-25% reduction in time and risk to mine hunting activities; Mine hunting sensors - Probability of Detection = 95%, Probability of Identification of Proud Mines = 90%, Probability of Classification of Buried Mines = 80%; Unmanned Systems for MCM sized for inclusion in the Littoral Combat Ship Mine Warfare Mission Package; MCM sensors sized, packaged and capable of 12 hour missions with a search rate greater than .05 square nautical mines per hour; Mine sweeping: Modular magnetic and acoustic influence sweeping systems packaged for deployment from Unmanned Surface Vehicles; Minesweeping single sortie coverage > 9.4 square nautical miles at 20 nautical miles per hour during a 4 hour mission up to Sea State 3; Surface-laid mine and obstacle breaching capability > 90% in the Beach Zone (BZ) using unitary warheads, and > 80% in the Surf Zone (SZ).

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	1.448	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.448

A. Mission Description and Budget Item Justification

This congressional increase further develops and demonstrates technologies to support a standoff or remote capability for detection and location, diagnosis, render safe, neutralization and enhanced access. Efforts include: electromagnetic, electro-optical, and acoustic sensors and systems for detection of explosive threat components including explosives, device housings/containers, and triggering mechanisms, standoff identification and confirmation of trace explosives, fusion of multiple-sensor input for high confidence detection and diagnosis of buried threats, highly dexterous manipulators and imitative controllers for lightweight, efficient (strength/weight ratio) dual manipulator systems integrated onto EOD robots for enhanced access, enhanced robotic autonomy to support EOD missions, data compression and visualization techniques to support precise render safe and neutralization, and neutralization devices containing reactive materials to neutralize devices with low collateral damage.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	1.448	0.000
FY 2016 Accomplishments: - Expand development of sensors that can be integrated into a handheld device or onto an EOD robot to detect deeply buried objects. - Expand development of excavation tools and techniques that can be integrated into a handheld device or onto an EOD robot for precision recovery and diagnosis of buried objects. - Expand development of neutralization tools and techniques that can be deployed by an EOD technician or integrated onto an EOD robot for effective target neutralization with low collateral damage.		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	1.448	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This activity supports the development and transition of technologies to PMS-408 for Joint Service missions. This S&T investment supports the Joint Requirements Oversight Council (JROC) and DoD EOD Program Board validated requirements for Joint EOD missions. This S&T investment provides critical S&T transitions to

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 9999 / *Congressional Adds*

the acquisition programs managed by PMS-408. This investment in Joint EOD S&T is reported annually to the DoD EOD Program Board. This S&T investment is documented in the DoD EOD Applied Research Program Plan which is reviewed and approved annually by the DoD EOD Program Board.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy	Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603801N *I (U) Innovative Naval Prototypes (INP) Adv Tech Dev*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	0.000	108.285	-	108.285	86.342	87.193	87.201	88.945	Continuing	Continuing
3400: *Innovative Naval Prototypes (INP) Adv Tech Dev*	0.000	0.000	0.000	108.285	-	108.285	86.342	87.193	87.201	88.945	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Innovative Naval Prototypes (INP) Program and its associated Leap Ahead Technology (LA-Tech) investments. These investments represent game changing technologies with the potential to revolutionize operational concepts. They are disruptive in nature as they would dramatically change the way naval forces fight. INPs push the imagination of our nation's technical talent to deliver transformational warfighting capabilities. The projects in this portfolio are high risk, technically challenging technology development efforts that offer the potential of high warfighting payoff in the future. The goal of these investments is to develop and demonstrate the viability of new technological capabilities via experimental prototypes that prove the new capability could be implemented if an acquisition program were to be established to further develop the demonstrated capability. These investments are selected by a process that involves senior leadership in the Department of the Navy, with new INPs approved by the 4-star RDT&E Corporate Board.

Developing INPs and Leap Ahead Technologies requires the development of subsystems and components, and efforts to integrate these subsystems and components into system prototypes for field experiments and tests in an appropriate environment. The efforts funded within this PE include concept and technology demonstrations of components and subsystems, which may be form, fit and function prototypes or scaled models that serve the same demonstration purpose. The goal of these development efforts is to prove the technological feasibility and assessment of subsystem and component operability and producibility rather than the development of hardware for service use. By demonstrating the general military utility and direct relevance to identified military needs, the pre-Milestone B technology becomes available for transition and further development within an emerging or new Program of Record. INPs and LA-Tech investments do not necessarily lead to subsequent development or procurement phases, but they do have the goal of moving out of Science and Technology (S&T) and into the acquisition process within the future years defense program (FYDP).

This is a new PE for FY 2018 that consolidates all Navy 6.3 Advanced Technology Development investments funding INPs and their associated LA-Tech investments into a single Navy 6.3 PE. In FY 2017, these investments were spread across 5 separate 6.3 PEs: 0603114N Power Projection Advanced Technology, 0603123N Force Protection Advanced Technology, 0603271N Electromagnetic Systems Advanced Technology, 0603747N Undersea Warfare Advanced Technology and 0603758N Navy Warfighting Experiments and Demonstrations. The consolidation in this PE allows all investments within this portfolio to be viewed in one place. It greatly enhances the visibility of the program by providing an easily navigable overview of all 6.3 Advanced Technology Development INP and LA-Tech investments.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*			**R-1 Program Element (Number/Name)** PE 0603801N *I (U) Innovative Naval Prototypes (INP) Adv Tech Dev*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	108.285	-	108.285
Total Adjustments	0.000	0.000	108.285	-	108.285
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	95.285	-	95.285
• Rate/Misc Adjustments	0.000	0.000	13.000	-	13.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603801N / *(U) Innovative Naval Prototypes (INP) Adv Tech Dev*	Project (Number/Name) 3400 / *Innovative Naval Prototypes (INP) Adv Tech Dev*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
3400: *Innovative Naval Prototypes (INP) Adv Tech Dev*	0.000	0.000	0.000	108.285	-	108.285	86.342	87.193	87.201	88.945	Continuing	Continuing

A. Mission Description and Budget Item Justification

INP investments are typically 4-8 years in duration. They provide a continuance of basic research by maturing technologies from a Technology Readiness Level (TRL) of 2 or 3 to a TRL of 6. All prototypes developed within this program require BA2 and BA3 funded technology development, which is coordinated to ensure the investments conclude with a demonstration proving the feasibility of the new technological capability in relevant environment. The portfolio is periodically refreshed through the selection of new INPs and Leap Ahead Technology (LA-Tech) investments as existing ones are completed. Successful demonstrations are intended to present the Department of the Navy with a programmatic challenge as these new capabilities can lead to the obsolescence of existing capabilities and significant decisions as to the path forward for integrating the new technological capabilities into the warfighting systems of the future.

INPs and LA-Tech investments, including FY17 jump-start efforts, have been collectively grouped into R-2 Activities that include Unmanned and Autonomous Systems, Directed Energy / Electric Weapons, Electromagnetic Maneuver Warfare, Cyber and Undersea Warfare.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: Cyber	0.000	0.000	5.238	0.000	5.238
Description: This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for cyber warfare. The Advanced Technology Development effort for the Total Platform Cyber Protection (TPCP) INP was previously funded in PE 0603123N Force Protection Advanced Technology Development. It was selected after the President's Budget for FY17 was delivered to the Congress. The FY 2018 amount reflects the sum total of all Budget Activity (BA) 6.3 Advanced Technology Development efforts in this INP. Starting in FY 2018, all INP/LA-Tech investments in Cyber warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area.					
FY 2016 Accomplishments: N/A					
FY 2017 Plans: N/A					
FY 2018 Base Plans: INP: Total Platform Cyber Protection (TPCP)					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603801N / *(U) Innovative Naval Prototypes (INP) Adv Tech Dev*	**Project (Number/Name)** 3400 / *Innovative Naval Prototypes (INP) Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Continue the BA 3 effort for the TPCP project, previously funded in PE 0603123N Force Protection Advanced Technology Development, which will develop leap-ahead resilient cybersecurity tools to enable our warfighting platforms to fight through current and future unauthorized cyber intrusions and ensure command and control of any Naval platform (submarine, surface, and air platforms) by providing an adaptive cyber toolkit and real time cyber sensors. This project develops a prototype and will demonstrate cyber sensors and automated vulnerability assessment cyber tools that deliver comprehensive defense-in-depth cyber capabilities to monitor, detect, mitigate, and recover from cyber threats in near real-time. Relevant naval cyber tools will be developed and tested to verify the technology can autonomously perform cyber vulnerability assessments and implement mitigation strategies that protect naval platforms from unauthorized cyber intrusions. New cyber autonomy tools will be developed to protect critical naval warfighting capabilities supporting multiple missions, including time critical strike, expeditionary warfare, anti-surface warfare, and anti-air warfare. These tools, which rely on cyber components, will be developed and demonstrated over an extended period of time at several integrated hardware in-the-loop facilities across the Naval Research Enterprise. Optimized cyber resiliency warfighting effectiveness will be developed and demonstrated. The technology will be developed to protect common layers of cyber functionality in hardware components, and local, system, and peripheral buses. The protection will be extended into the system BIOS, hypervisor, operating system, middleware, the application space, and the network infrastructure. ***FY 2018 OCO Plans:*** N/A					
Title: Directed Energy / Electric Weapons ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for directed energy and electric weapons. FY 2018 reflects the sum total of all such BA 6.3 Advanced Technology Development efforts in the program. Some of these efforts were previously funded in PE 0603114N Power Projection Advanced Technology Development and 0603758N Navy Warfighting Experiments and Demonstrations. Starting in FY 2018, all INP and LA-Tech investments in directed energy and electric weapons will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:***	0.000	0.000	35.529	0.000	35.529

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603801N / *(U) Innovative Naval Prototypes (INP) Adv Tech Dev*	**Project (Number/Name)** 3400 / *Innovative Naval Prototypes (INP) Adv Tech Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Electro-Magnetic Railgun (EMRG) Continue EMRG, which was previously funded in 0603114N Force Protection Advanced Technology Development. The EMRG capability will support Naval Surface Fire Support (NSFS), Integrated Air and Missile Defense (IAMD), Fast Attack Craft and Fast Inshore Attack Craft (FAC/FIAC) and Anti-Surface Warfare (ASuW) missions. Design, fabricate and integrate Electro Magnetic (EM) railgun subsystems and components into a system prototype capable of rep-rate operations. Assess the manufacturability of major components such as the railgun launcher and pulsed power modules, which are key to the technology capability. Conduct preliminary prototype system tests and demonstrations to prove the technological feasibility of the EMRG capability and assess sub-system and component operability under stressing rep-rate conditions. Continue developing and testing a prototype rep-rate railgun launcher that is suitable for installation in a prototype railgun gun mount, where the design of the power and energy architecture necessary to support the prototype EMRG system can be assessed. Continue to test and build full-scale electro-magnetic railgun system prototypes that include the battery charging system, the pulsed power subsystem, and the electromagnetic launcher. Perform full-scale testing of long-life railgun launcher material solutions inserted in laboratory launchers. Design, build, test, and evaluate iterative electromagnetic railgun composite launcher prototypes to demonstrate the technological feasibility, performance, multi-shot life, and suitable firing rate of the system. Continue activities to integrate and test a Hyper Velocity Projectile (HVP) for use with the EMRG. LA-Tech: Solid State Laser Technology Maturation (SSL TM) Complete SSL TM, which was previously funded in 0603114N Force Protection Advanced Technology Development. Continue development of a maritime laser weapons system prototype and test it on a representative test platform for a naval surface combatant. Conduct the required laser weapon system engineering, design, integration and testing necessary to have a testable, experimental prototype. This system will be capable of supporting missions such as defense against small boat and Unmanned Aerial Vehicle (UAV) swarms and Intelligence, Surveillance and Reconnaissance (ISR) disruption and defeat. The results of scientific and engineering trade studies, including those that measure atmospheric absorption and turbulence, will be used					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
to support the integration and testing of a maritime beam director and a high power, Solid State Laser (SSL) capable of tracking and engaging surface and airborne targets at a relevant stand-off distance in the maritime environment. A Hybrid Predictive Avoidance Safety System (HPASS) will be integrated with a solid state laser weapon system demonstrator to de-conflict laser operations with friendly sensors and platforms. At-sea testing will be conducted on the full laser weapon system demonstrator (i.e., prototype) from a representative test platform for a naval surface combatant. LA-Tech: High-power Joint Electromagnetic Non-Kinetic Strike (HIJENKS) Continue HIJENKS, a joint USAF/USN project previously funded as a FY17 Leap-Ahead jump start effort in PE 0603758N Navy Warfighting Experiments and Demonstrations emergent technology breakthroughs technology. Develop a High Power Radio Frequency (HPRF) technology payload integrated on an air platform capable of engaging multiple electronic targets with a single, scalable effects weapon across a variety of warfighting missions. This effort will culminate in a live fire demonstration of a multi-mission/multi-target HPRF payload integrated into a demonstration platform. The operational impacts include decreased cost exchange ratios, non-kinetic counter electronic effects, reduced collateral damage, and the ability to engage multiple targets with a single weapon. This effort aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. During FY18, the following advanced technology development efforts are planned: conduct system requirements and preliminary design assessments to further mature the development of an HPRF advanced development (prototype) system; perform trade studies to examine different technical approaches for developing the HPRF prototype and assessing the Technology Readiness Level (TRL) of emerging HPRF sources; begin the initial design of HPRF advanced payload activities; refine the prototype system performance requirements with input from operational stakeholders; study platform integration approaches and begin integration design activities; begin developing the hardware and software required to integrate an advanced HPRF payload for a future demonstration; analyze platform modifications; begin testing target classes for the Radio Frequency (RF) waveform specification being developed in BA 6.2; conduct kill-chain studies to identify and recommend design trade-offs to enable weapon system interoperability; begin live fire demonstration planning; and begin conceptually designing the next generation RF source technology. ***FY 2018 OCO Plans:*** N/A					
Title: Electromagnetic Maneuver Warfare	0.000	0.000	16.839	0.000	16.839

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Electromagnetic Maneuver Warfare (EMW). FY 2018 reflects the sum total of all such BA 6.3 Advanced Technology Development efforts in the program. These efforts were previously funded in PE 0603271N Electromagnetic Systems Advanced Technology Development. Starting in FY 2018, all INP and LA-Tech investments in Electromagnetic Maneuver Warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Electromagnetic Maneuver & Control Capability (EMC2) Continue the EMC2 project, which was previously funded in 0603271N Electromagnetic Systems Advanced Technology Development. The EMC2 project will enable a battle group to work cooperatively in the Electromagnetic Spectrum (EMS) by optimizing Electronic Warfare (EW), Information Operations (IO), communications, and radar performance. EMC2 will incorporate the results of its ongoing advanced technology development efforts in Radio Frequency (RF) resource optimization into the Resource Allocation Manager (RAM) construct that was previously developed for single multifunction systems under the InTop program, which optimized spectrum and functional use across a platform and an entire strike group. EMC2 will begin building a Lowband RF Intelligent Distribution Resource (LowRIDR) prototype and continue efforts to develop a multifunction control system for LowRIDR. EMC2 will also begin building the necessary advanced technology components of a wideband, multifunction airborne system that can be integrated with ship-based wideband, multifunction systems. Experimentation and demonstrations will be performed to determine how best to utilize the wideband, multifunction systems that have already been delivered {i.e., Wideband Submarine Satellite Communications (SubSatCom), EW/IO/Communications and Flexible, Distributed Array Radar (FlexDAR)} to enable EMW and provide the ability to dominate the EMS domain. INP: Nemesis					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Complete the Nemesis project, previously funded in 0603271N Electromagnetic Systems Advanced Technology Development, by designing and building prototype Nemesis payloads that implement industry standards for software, hardware, and firmware interfaces. Nemesis expendable decoys and prototype system hardware will be completed and delivered for field testing. Demonstrations of Nemesis platforms and payload will be conducted during fleet experimentation, as well as during focused field and laboratory tests. ***FY 2018 OCO Plans:*** N/A					
Title: Undersea Warfare ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Undersea Maneuver Warfare. FY 2018 reflects the sum total of all such BA 6.3 Advanced Technology Development efforts in the program. These efforts were previously funded in PE 0603123N Force Protection Advanced Technology Development and 0603747N Undersea Warfare Advanced Technology Development. Starting in FY 2018, all INP and LA-Tech investments in Undersea Maneuver Warfare will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Forward Deployed Energy & Communications Outpost (FDECO) Continue FDECO, which was previously funded in PE 0603123N Force Protection Advanced Technology Development. Incorporate results from the FDECO architecture planning study into the FDECO design. Begin integrating FDECO component technologies into experimental FDECO subsystems and utilize the results of limited objective experiments to begin developing a future demonstration plan. Continue to demonstrate FDECO's ability and capacity to support vehicle agnostic docking, autonomous and efficient energy management, and federated command & control (C2) of the system and hosted assets. Continue to demonstrate	0.000	0.000	13.168	0.000	13.168

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
notional intelligence preparation of the operational environment and begin demonstrating notional mine warfare and anti-submarine warfare capabilities. LA-Tech: Anti-Submarine Warfare Mission Packages (ASW MP) Continue ASW MP, which was previously funded in PE 0603747N Undersea Warfare Advanced Technology Development. The ASW MP will develop a system of sensors and autonomy algorithms to enable a Large Displacement Unmanned Undersea Vehicle (LDUUV) to conduct a classified ASW mission. Advanced technology development funds will be used to integrate sensor components and autonomy algorithms developed in PE 0602792N into the mission packages system. During FY18, an Unmanned Undersea Vehicle (UUV) will be selected to be used for the ASW mission and measurements will be taken of its characteristics. New designs for situational awareness sensor electronics and components will be integrated into the UUV. The project will also conduct modeling and simulation of the integrated components of the selected UUV for the ASW mission to evaluate overall integrated system performance. ***FY 2018 OCO Plans:*** N/A					
Title: Unmanned and Autonomous Systems ***Description:*** This R-2 Activity contains all Innovative Prototype (INP) and associated Leap Ahead Technology (LA-Tech) investments that are developing new technologies for Unmanned and Autonomous Systems. FY 2018 reflects the sum total of all such BA 6.3 Advanced Technology Development efforts in the program. These efforts were previously funded in PE 0603123N Force Protection Advanced Technology Development and 0603747N Undersea Warfare Advanced Technology Development. Starting in FY 2018, all INP and LA-Tech investments in Unmanned and Autonomous Systems will be shown in this R-2 Activity to better convey exactly what the Office of Naval Research is working on in this area. ***FY 2016 Accomplishments:*** N/A ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** INP: Autonomous Aerial Cargo/Utility System (AACUS)	0.000	0.000	37.511	0.000	37.511

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Complete the AACUS project, which was previously funded in PE 0603123N Force Protection Advanced Technology Development. Continue development of the design and build of a prototype sensor suite and software package suitable for integration and testing on an existing USMC rotary wing aircraft that will enable the capability for optional unmanned autonomous flight. Conduct development and planning for a demonstration of the system's ability to autonomously perform an assault support mission in an operationally representative environment. This demonstration will include performing autonomous take-off, conducting en route navigation, approaching and landing at multiple unprepared landing zones using supervisory control managed by a minimally trained Marine via a tablet-based application, detecting and avoiding ground-based obstacles, and safely operating in degraded visual environments. INP: Claws Initiate Claws. Claws will develop the autonomy required to operate large and extra-large Unmanned Undersea Vehicles (UUVs) in an anti-access, anti-denial environment. To support large and extra-large UUV operations further forward and farther from the battle group, the technology will be evolved to allow operations with limited navigational fixes and limited communication opportunities. During FY18, at-sea testing of Technology Readiness Level (TRL) 5 research technologies will be initiated in a realistic environment. At-sea data will be collected to support the further development of Claws technologies emerging out of the Claws applied research effort in PE 0602792N. Analysis of promising technologies will be conducted using laboratory and at-sea testing to provide realistic performance data. INP: Large Displacement Unmanned Undersea Vehicle (LDUUV) Complete LDUUV, which was previously funded in PE 0603747N Undersea Warfare Advanced Technology Development. Continue progress developing a prototype LDUUV and demonstrate the autonomy technology that enables the LDUUV to avoid undersea static obstacles, operate in a variety of currents, and adapt to local environments so as to maintain station. Conduct development, testing and demonstration of the endurance technology and recommend a reliability strategy allowing for 30 days of continuous operations. Conduct a demonstration of the LDUUV fuel cell system installed in an LDUUV vehicle operating in an Intelligence Surveillance Reconnaissance (ISR) like mission for 60 days. Continue to document the data analysis from the technology development in order to transition the information to Program Executive Office for the Littoral Combat Ship.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
INP: Low-Cost UAV Swarming Technology (LOCUST) Initiate the BA 3 technology development effort for the LOCUST project, which will ultimately deliver a scalable system of inexpensive Unmanned Aerial Vehicles (UAVs) and payloads that will provide game-changing disruptive capabilities over a wide range of military operations and areas of operations. LOCUST will make advances in unmanned system collective autonomous behaviors, robust low probability of interception or detection ad hoc networks, and payload miniaturization and modularity breakthroughs to counter threats in constrained urban environments, as well as large-scale anti-access area denial defenses. This will be accomplished at greatly reduced cost and risk when compared to traditional manned platform target prosecution. During FY18, the LOCUST program will begin to develop a range of key technologies that will be integrated together in order to demonstrate a scalable system of inexpensive, commoditized, swarming UAVs that provide disruptive capabilities. Critical milestones for each major sub-system and system will be established, as well as a revisit to requirements and metrics throughout. Yearly wargames will be utilized to shape and inform the demonstrations, which will be of increasing complexity in both mission and operating environment. The demonstrations in turn will provide the Navy with an ability to spiral out capability as needed. FY18 demonstrations are planned to encompass missions utilizing intelligence, surveillance and reconnaissance and kinetic strike payloads. LA-Tech: Medium Displacement Unmanned Surface Vehicle (MDUSV) Continue the MDUSV project, which was previously funded in 0603123N Force Protection Advanced Technology Development. The MDUSV project will design and build a prototype MDUSV platform sized for theater or global independent operations. New autonomy, Mine Countermeasures (MCM), Anti-Submarine Warfare (ASW), and Electronic Warfare (EW) technologies will be integrated into the MDUSV platform. The capability of the MSUSV to autonomously perform ASW, MCM and EW missions over an extended period of time will be demonstrated during a 40-day period of at-sea testing. The capability to autonomously operate in all-weather conditions, using new technologies that provide robust perception using Electro-Optic/Infrared (EO/IR) sensors that detect low radar cross-section craft with reduced vulnerability to jamming and reduced Radio Frequency (RF) emissions, will be assessed. The use of integrated acoustic and High Temperature Superconductor (HTS) mine influence sweep technologies as well as a novel ASW sensor suite that includes an advanced version of the Non-Traditional Sensor System (NTSS) will be tested on an instrumented range.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
LA-Tech: Tern Complete Tern, a joint ONR and DARPA effort, previously funded in 0603123N Force Protection Advanced Technology Development. Continue TERN technology development by conducting hardware and software testing and a sea-based Vertical Take-Off and Landing (VTOL) flight demonstration. The developed Tern enabling technologies have been focused on supporting a DDG-51 and LCS-2 based future long endurance Unmanned Air Vehicle (UAV) capability that could be transitioned and implemented with minimal ship modification. ***FY 2018 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	0.000	0.000	108.285	0.000	108.285

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

In all cases, the technologies being developed within this PE support the Department of the Navy INP Program and are managed at the Office of Naval Research. The primary technological metrics used in this PE involve experiments and tests that demonstrate proof of concept for the technological capability being developed. All investments are coordinated with the acquisition, resources/requirements, and Fleet communities, with periodic briefs given to the Department of the Navy's leadership, including the 4-star RDT&E Corporate Board. At the lowest level, each project is measured against technical and financial milestones on a periodic and frequent basis. Annually, each project is reviewed in depth for technical performance and development status by the Chief of Naval Research. Department of the Navy leadership, including the RDT&E Corporate Board is briefed on the program's status at least annually, if not more often, by the Chief of Naval Research.