Department of Defense
Fiscal Year (FY) 2019 Budget Estimates

February 2018

Navy

Justification Book Volume 1 of 5

Research, Development, Test & Evaluation, Navy

Budget Activities 1, 2, and 3

The estimated cost for this report for the Department of the Navy (DON) is $20,747.

The estimated total cost for supporting the DON budget justification material is approximately $1,643,653 for the 2018 fiscal year. This includes $79,753 in supplies and $1,563,900 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, $18,649,478,000 to remain available for obligation until September 30, 2020.

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

Appropriation	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Research, Development, Test & Eval, Navy	17,851,955	17,116,976	17,091,976	326,537	326,537
Total Research, Development, Test & Evaluation	17,851,955	17,116,976	17,091,976	326,537	326,537
Other RDT&E Budget Activities Not Included in the Research, Development, Test and Evaluation Title					
National Defense Sealift Fund	7,237	18,622	18,622		
Total Not in Research, Development, Test & Evaluation	7,237	18,622	18,622		

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

Appropriation	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
Research, Development, Test & Eval, Navy	60,000	-60,000		17,478,513	-60,000	17,418,513
Total Research, Development, Test & Evaluation	60,000	-60,000		17,478,513	-60,000	17,418,513
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 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Appropriation	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research, Development, Test & Eval, Navy	18,451,066	198,412	18,649,478
Total Research, Development, Test & Evaluation	18,451,066	198,412	18,649,478

Other RDT&E Budget Activities Not Included in the Research, Development, Test and Evaluation Title

National Defense Sealift Fund			
Total Not in Research, Development, Test & Evaluation			

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

Summary Recap of Budget Activities	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Basic Research	549,384	595,901	595,901		
Applied Research	954,884	886,079	886,079		
Advanced Technology Development	811,211	686,342	686,342		
Advanced Component Development & Prototypes	4,510,800	4,218,714	4,193,714	27,710	59,510
System Development & Demonstration	5,928,185	6,362,102	6,362,102		5,400
Management Support	1,279,290	945,757	945,757		
Operational Systems Development	3,818,201	3,980,140	3,980,140	102,655	102,655
Undistributed		-558,059	-558,059	196,172	158,972
Total Research, Development, Test & Evaluation	17,851,955	17,116,976	17,091,976	326,537	326,537

Summary Recap of FYDP Programs					
Strategic Forces	187,327	201,735	201,735		
General Purpose Forces	1,407,847	1,675,797	1,675,797	12,800	12,800
Intelligence and Communications	927,792	751,779	751,779		
Research and Development	13,686,598	13,589,349	13,564,349	27,710	64,910
Central Supply and Maintenance	40,169	43,035	43,035		
Administration and Associated Activities	136	-556,310	-556,310	196,172	158,972
Space		47,244	47,244		
Classified Programs	1,602,086	1,364,347	1,364,347	89,855	89,855
Total Research, Development, Test & Evaluation	17,851,955	17,116,976	17,091,976	326,537	326,537

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

Summary Recap of Budget Activities	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
Basic Research				595,901		595,901
Applied Research				886,079		886,079
Advanced Technology Development				686,342		686,342
Advanced Component Development & Prototypes				4,253,224		4,253,224
System Development & Demonstration				6,367,502		6,367,502
Management Support				945,757		945,757
Operational Systems Development	60,000	-60,000		4,142,795	-60,000	4,082,795
Undistributed				-399,087		-399,087
Total Research, Development, Test & Evaluation	60,000	-60,000		17,478,513	-60,000	17,418,513

Summary Recap of FYDP Programs						
Strategic Forces				201,735		201,735
General Purpose Forces				1,688,597		1,688,597
Intelligence and Communications				751,779		751,779
Research and Development				13,629,259		13,629,259
Central Supply and Maintenance				43,035		43,035
Administration and Associated Activities				-397,338		-397,338
Space				47,244		47,244
Classified Programs	60,000	-60,000		1,514,202	-60,000	1,454,202
Total Research, Development, Test & Evaluation	60,000	-60,000		17,478,513	-60,000	17,418,513

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

Summary Recap of Budget Activities	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Basic Research	597,378		597,378
Applied Research	891,471		891,471
Advanced Technology Development	750,995		750,995
Advanced Component Development & Prototypes	4,293,713	33,300	4,327,013
System Development & Demonstration	6,042,480	1,100	6,043,580
Management Support	1,020,569		1,020,569
Operational Systems Development	4,854,460	164,012	5,018,472
Undistributed			
Total Research, Development, Test & Evaluation	18,451,066	198,412	18,649,478

Summary Recap of FYDP Programs			
Strategic Forces	251,501		251,501
General Purpose Forces	1,982,258	16,130	1,998,388
Intelligence and Communications	626,028		626,028
Research and Development	13,979,095	34,400	14,013,495
Central Supply and Maintenance	43,844		43,844
Administration and Associated Activities	1,579		1,579
Space	47,858		47,858
Classified Programs	1,518,903	147,882	1,666,785
Total Research, Development, Test & Evaluation	18,451,066	198,412	18,649,478

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

	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Summary Recap of Non-RDT&E Title FYDP Programs					
Mobility Forces	7,237	18,622	18,622		
Total Research, Development, Test & Evaluation	7,237	18,622	18,622		

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

	FY 2018 Emergency Requests**	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
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 Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Summary Recap of Non-RDT&E Title FYDP Programs			
Mobility Forces			
Total Research, Development, Test & Evaluation			

Department of the Navy
FY 2019 President's Budget
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Advanced Component Development & Prototypes	4,510,800	4,218,714	4,193,714	27,710	59,510
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Management Support	1,279,290	945,757	945,757		
Operational Systems Development	3,818,201	3,980,140	3,980,140	102,655	102,655
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Classified Programs	1,602,086	1,364,347	1,364,347	89,855	89,855
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Department of the Navy
FY 2019 President's Budget
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Administration and Associated Activities				-397,338		-397,338
Space				47,244		47,244
Classified Programs	60,000	-60,000		1,514,202	-60,000	1,454,202
Total Research, Development, Test & Evaluation	60,000	-60,000		17,478,513	-60,000	17,418,513

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

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
1	0601103N	University Research Initiatives	01	117,320	118,130	118,130			U
2	0601152N	In-House Laboratory Independent Research	01	18,238	19,438	19,438			U
3	0601153N	Defense Research Sciences	01	413,826	458,333	458,333			U
	Basic	Research		549,384	595,901	595,901			
4	0602114N	Power Projection Applied Research	02	69,950	13,553	13,553			U
5	0602123N	Force Protection Applied Research	02	192,579	125,557	125,557			U
6	0602131M	Marine Corps Landing Force Technology	02	67,874	53,936	53,936			U
7	0602235N	Common Picture Applied Research	02	40,649	36,450	36,450			U
8	0602236N	Warfighter Sustainment Applied Research	02	50,465	48,649	48,649			U
9	0602271N	Electromagnetic Systems Applied Research	02	114,613	79,598	79,598			U
10	0602435N	Ocean Warfighting Environment Applied Research	02	79,941	42,411	42,411			U
11	0602651M	Joint Non-Lethal Weapons Applied Research	02	6,146	6,425	6,425			U
12	0602747N	Undersea Warfare Applied Research	02	120,537	56,094	56,094			U
13	0602750N	Future Naval Capabilities Applied Research	02	152,427	156,805	156,805			U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02	31,256	32,733	32,733			U

Department of the Navy
FY 2019 President's Budget
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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 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
1	0601103N	University Research Initiatives	01				118,130		118,130	U
2	0601152N	In-House Laboratory Independent Research	01				19,438		19,438	U
3	0601153N	Defense Research Sciences	01				458,333		458,333	U
	Basic Research						595,901		595,901	
4	0602114N	Power Projection Applied Research	02				13,553		13,553	U
5	0602123N	Force Protection Applied Research	02				125,557		125,557	U
6	0602131M	Marine Corps Landing Force Technology	02				53,936		53,936	U
7	0602235N	Common Picture Applied Research	02				36,450		36,450	U
8	0602236N	Warfighter Sustainment Applied Research	02				48,649		48,649	U
9	0602271N	Electromagnetic Systems Applied Research	02				79,598		79,598	U
10	0602435N	Ocean Warfighting Environment Applied Research	02				42,411		42,411	U
11	0602651M	Joint Non-Lethal Weapons Applied Research	02				6,425		6,425	U
12	0602747N	Undersea Warfare Applied Research	02				56,094		56,094	U
13	0602750N	Future Naval Capabilities Applied Research	02				156,805		156,805	U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02				32,733		32,733	U

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

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

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
1	0601103N	University Research Initiatives	01	119,433		119,433	U
2	0601152N	In-House Laboratory Independent Research	01	19,237		19,237	U
3	0601153N	Defense Research Sciences	01	458,708		458,708	U
	Basic	Research		597,378		597,378	
4	0602114N	Power Projection Applied Research	02	14,643		14,643	U
5	0602123N	Force Protection Applied Research	02	124,049		124,049	U
6	0602131M	Marine Corps Landing Force Technology	02	59,607		59,607	U
7	0602235N	Common Picture Applied Research	02	36,348		36,348	U
8	0602236N	Warfighter Sustainment Applied Research	02	56,197		56,197	U
9	0602271N	Electromagnetic Systems Applied Research	02	83,800		83,800	U
10	0602435N	Ocean Warfighting Environment Applied Research	02	42,998		42,998	U
11	0602651M	Joint Non-Lethal Weapons Applied Research	02	6,349		6,349	U
12	0602747N	Undersea Warfare Applied Research	02	58,049		58,049	U
13	0602750N	Future Naval Capabilities Applied Research	02	147,771		147,771	U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02	37,545		37,545	U

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
15	0602792N	Innovative Naval Prototypes (INP) Applied Research	02		171,146	171,146			U
16	0602861N	Science and Technology Management - ONR Field Acitivities	02		62,722	62,722			U
17	0602898N	Science and Technology Management - ONR Headquarters	02	28,447					U
		Applied Research		954,884	886,079	886,079			
18	0603114N	Power Projection Advanced Technology	03	97,122					U
19	0603123N	Force Protection Advanced Technology	03	83,146	26,342	26,342			U
20	0603271N	Electromagnetic Systems Advanced Technology	03	25,726	9,360	9,360			U
21	0603640M	USMC Advanced Technology Demonstration (ATD)	03	137,190	154,407	154,407			U
22	0603651M	Joint Non-Lethal Weapons Technology Development	03	12,790	13,448	13,448			U
23	0603671N	Navy Advanced Technology Development (ATD)	03						U
24	0603673N	Future Naval Capabilities Advanced Technology Development	03	254,203	231,772	231,772			U
25	0603680N	Manufacturing Technology Program	03	55,555	57,797	57,797			U
26	0603729N	Warfighter Protection Advanced Technology	03	39,486	4,878	4,878			U
27	0603747N	Undersea Warfare Advanced Technology	03	25,352					U
28	0603758N	Navy Warfighting Experiments and Demonstrations	03	67,965	64,889	64,889			U

Department of the Navy
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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 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
15	0602792N	Innovative Naval Prototypes (INP) Applied Research	02				171,146		171,146	U
16	0602861N	Science and Technology Management - ONR Field Acitivities	02				62,722		62,722	U
17	0602898N	Science and Technology Management - ONR Headquarters	02							U
		Applied Research					886,079		886,079	
18	0603114N	Power Projection Advanced Technology	03							U
19	0603123N	Force Protection Advanced Technology	03				26,342		26,342	U
20	0603271N	Electromagnetic Systems Advanced Technology	03				9,360		9,360	U
21	0603640M	USMC Advanced Technology Demonstration (ATD)	03				154,407		154,407	U
22	0603651M	Joint Non-Lethal Weapons Technology Development	03				13,448		13,448	U
23	0603671N	Navy Advanced Technology Development (ATD)	03							U
24	0603673N	Future Naval Capabilities Advanced Technology Development	03				231,772		231,772	U
25	0603680N	Manufacturing Technology Program	03				57,797		57,797	U
26	0603729N	Warfighter Protection Advanced Technology	03				4,878		4,878	U
27	0603747N	Undersea Warfare Advanced Technology	03							U
28	0603758N	Navy Warfighting Experiments and Demonstrations	03				64,889		64,889	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 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
15	0602792N	Innovative Naval Prototypes (INP) Applied Research	02	159,697		159,697	U
16	0602861N	Science and Technology Management - ONR Field Acitivities	02	64,418		64,418	U
17	0602898N	Science and Technology Management - ONR Headquarters	02				U
		Applied Research		891,471		891,471	
18	0603114N	Power Projection Advanced Technology	03				U
19	0603123N	Force Protection Advanced Technology	03	2,423		2,423	U
20	0603271N	Electromagnetic Systems Advanced Technology	03				U
21	0603640M	USMC Advanced Technology Demonstration (ATD)	03	150,245		150,245	U
22	0603651M	Joint Non-Lethal Weapons Technology Development	03	13,313		13,313	U
23	0603671N	Navy Advanced Technology Development (ATD)	03	131,502		131,502	U
24	0603673N	Future Naval Capabilities Advanced Technology Development	03	232,996		232,996	U
25	0603680N	Manufacturing Technology Program	03	58,657		58,657	U
26	0603729N	Warfighter Protection Advanced Technology	03				U
27	0603747N	Undersea Warfare Advanced Technology	03				U
28	0603758N	Navy Warfighting Experiments and Demonstrations	03				U

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Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
29	0603782N	Mine and Expeditionary Warfare Advanced Technology	03	12,676	15,164	15,164			U
30	0603801N	Innovative Naval Prototypes (INP) Advanced Technology Development	03		108,285	108,285			U
		Advanced Technology Development		811,211	686,342	686,342			
31	0603207N	Air/Ocean Tactical Applications	04	44,175	48,365	48,365			U
32	0603216N	Aviation Survivability	04	14,811	5,566	5,566			U
33	0603251N	Aircraft Systems	04	1,519	695	695			U
34	0603254N	ASW Systems Development	04	6,877	7,661	7,661			U
35	0603261N	Tactical Airborne Reconnaissance	04	3,265	3,707	3,707			U
36	0603382N	Advanced Combat Systems Technology	04	3,583	61,381	61,381			U
37	0603502N	Surface and Shallow Water Mine Countermeasures	04	126,761	154,117	154,117			U
38	0603506N	Surface Ship Torpedo Defense	04	69,872	14,974	14,974			U
39	0603512N	Carrier Systems Development	04	7,516	9,296	9,296			U
40	0603525N	PILOT FISH	04	137,435	132,083	132,083			U
41	0603527N	RETRACT LARCH	04	48,583	15,407	15,407	22,000	22,000	U
42	0603536N	RETRACT JUNIPER	04	107,871	122,413	122,413			U
43	0603542N	Radiological Control	04	677	745	745			U
44	0603553N	Surface ASW	04	1,039	1,136	1,136			U
45	0603561N	Advanced Submarine System Development	04	120,289	100,955	100,955			U

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29	0603782N	Mine and Expeditionary Warfare Advanced Technology	03				15,164		15,164	U
30	0603801N	Innovative Naval Prototypes (INP) Advanced Technology Development	03				108,285		108,285	U
		Advanced Technology Development					686,342		686,342	
31	0603207N	Air/Ocean Tactical Applications	04				48,365		48,365	U
32	0603216N	Aviation Survivability	04				5,566		5,566	U
33	0603251N	Aircraft Systems	04				695		695	U
34	0603254N	ASW Systems Development	04				7,661		7,661	U
35	0603261N	Tactical Airborne Reconnaissance	04				3,707		3,707	U
36	0603382N	Advanced Combat Systems Technology	04				61,381		61,381	U
37	0603502N	Surface and Shallow Water Mine Countermeasures	04				154,117		154,117	U
38	0603506N	Surface Ship Torpedo Defense	04				14,974		14,974	U
39	0603512N	Carrier Systems Development	04				9,296		9,296	U
40	0603525N	PILOT FISH	04				132,083		132,083	U
41	0603527N	RETRACT LARCH	04				37,407		37,407	U
42	0603536N	RETRACT JUNIPER	04				122,413		122,413	U
43	0603542N	Radiological Control	04				745		745	U
44	0603553N	Surface ASW	04				1,136		1,136	U
45	0603561N	Advanced Submarine System Development	04				100,955		100,955	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
29	0603782N	Mine and Expeditionary Warfare Advanced Technology	03				U
30	0603801N	Innovative Naval Prototypes (INP) Advanced Technology Development	03	161,859		161,859	U
		Advanced Technology Development		750,995		750,995	
31	0603207N	Air/Ocean Tactical Applications	04	29,747		29,747	U
32	0603216N	Aviation Survivability	04	7,050		7,050	U
33	0603251N	Aircraft Systems	04	793		793	U
34	0603254N	ASW Systems Development	04	7,058		7,058	U
35	0603261N	Tactical Airborne Reconnaissance	04	3,540		3,540	U
36	0603382N	Advanced Combat Systems Technology	04	59,741		59,741	U
37	0603502N	Surface and Shallow Water Mine Countermeasures	04	62,727		62,727	U
38	0603506N	Surface Ship Torpedo Defense	04	8,570		8,570	U
39	0603512N	Carrier Systems Development	04	5,440		5,440	U
40	0603525N	PILOT FISH	04	162,222		162,222	U
41	0603527N	RETRACT LARCH	04	11,745	18,000	29,745	U
42	0603536N	RETRACT JUNIPER	04	114,265		114,265	U
43	0603542N	Radiological Control	04	740		740	U
44	0603553N	Surface ASW	04	1,122		1,122	U
45	0603561N	Advanced Submarine System Development	04	109,086		109,086	U

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46	0603562N	Submarine Tactical Warfare Systems	04	8,603	13,834	13,834			U
47	0603563N	Ship Concept Advanced Design	04	14,359	36,891	36,891			U
48	0603564N	Ship Preliminary Design & Feasibility Studies	04	13,451	12,012	12,012			U
49	0603570N	Advanced Nuclear Power Systems	04	453,313	329,500	329,500			U
50	0603573N	Advanced Surface Machinery Systems	04	30,255	29,953	29,953			U
51	0603576N	CHALK EAGLE	04	353,146	191,610	191,610			U
52	0603581N	Littoral Combat Ship (LCS)	04	50,806	40,991	40,991			U
53	0603582N	Combat System Integration	04	23,839	24,674	24,674			U
54	0603595N	Ohio Replacement	04	681,164	776,158	776,158			U
55	0603596N	LCS Mission Modules	04	153,595	116,871	116,871			U
56	0603597N	Automated Test and Analysis	04	14,507	8,052	8,052			U
57	0603599N	Frigate Development	04	83,080	143,450	143,450			U
58	0603609N	Conventional Munitions	04	8,342	8,909	8,909			U
59	0603611M	Marine Corps Assault Vehicles	04	131,381					U
60	0603635M	Marine Corps Ground Combat/Support System	04	1,043	1,428	1,428			U
61	0603654N	Joint Service Explosive Ordnance Development	04	48,686	53,367	53,367		29,700	U
62	0603713N	Ocean Engineering Technology Development	04	4,639	8,212	8,212			U
63	0603721N	Environmental Protection	04	19,117	20,214	20,214			U

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46	0603562N	Submarine Tactical Warfare Systems	04				13,834		13,834	U
47	0603563N	Ship Concept Advanced Design	04				36,891		36,891	U
48	0603564N	Ship Preliminary Design & Feasibility Studies	04				12,012		12,012	U
49	0603570N	Advanced Nuclear Power Systems	04				329,500		329,500	U
50	0603573N	Advanced Surface Machinery Systems	04				29,953		29,953	U
51	0603576N	CHALK EAGLE	04				191,610		191,610	U
52	0603581N	Littoral Combat Ship (LCS)	04				40,991		40,991	U
53	0603582N	Combat System Integration	04				24,674		24,674	U
54	0603595N	Ohio Replacement	04				776,158		776,158	U
55	0603596N	LCS Mission Modules	04				116,871		116,871	U
56	0603597N	Automated Test and Analysis	04				8,052		8,052	U
57	0603599N	Frigate Development	04				143,450		143,450	U
58	0603609N	Conventional Munitions	04				8,909		8,909	U
59	0603611M	Marine Corps Assault Vehicles	04							U
60	0603635M	Marine Corps Ground Combat/Support System	04				1,428		1,428	U
61	0603654N	Joint Service Explosive Ordnance Development	04				83,067		83,067	U
62	0603713N	Ocean Engineering Technology Development	04				8,212		8,212	U
63	0603721N	Environmental Protection	04				20,214		20,214	U

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46	0603562N	Submarine Tactical Warfare Systems	04	9,374		9,374	U
47	0603563N	Ship Concept Advanced Design	04	89,419		89,419	U
48	0603564N	Ship Preliminary Design & Feasibility Studies	04	13,348		13,348	U
49	0603570N	Advanced Nuclear Power Systems	04	256,137		256,137	U
50	0603573N	Advanced Surface Machinery Systems	04	22,109		22,109	U
51	0603576N	CHALK EAGLE	04	29,744		29,744	U
52	0603581N	Littoral Combat Ship (LCS)	04	27,997		27,997	U
53	0603582N	Combat System Integration	04	16,351		16,351	U
54	0603595N	Ohio Replacement	04	514,846		514,846	U
55	0603596N	LCS Mission Modules	04	103,633		103,633	U
56	0603597N	Automated Test and Analysis	04	7,931		7,931	U
57	0603599N	Frigate Development	04	134,772		134,772	U
58	0603609N	Conventional Munitions	04	9,307		9,307	U
59	0603611M	Marine Corps Assault Vehicles	04				U
60	0603635M	Marine Corps Ground Combat/Support System	04	1,828		1,828	U
61	0603654N	Joint Service Explosive Ordnance Development	04	43,148	13,900	57,048	U
62	0603713N	Ocean Engineering Technology Development	04	5,915		5,915	U
63	0603721N	Environmental Protection	04	19,811		19,811	U

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64	0603724N	Navy Energy Program	04	69,500	50,623	25,623			U
65	0603725N	Facilities Improvement	04	4,213	2,837	2,837			U
66	0603734N	CHALK CORAL	04	225,665	245,143	245,143			U
67	0603739N	Navy Logistic Productivity	04	2,973	2,995	2,995			U
68	0603746N	RETRACT MAPLE	04	301,871	306,101	306,101			U
69	0603748N	LINK PLUMERIA	04	259,756	253,675	253,675			U
70	0603751N	RETRACT ELM	04	51,720	55,691	55,691			U
71	0603764N	LINK EVERGREEN	04	46,282	48,982	48,982			U
72	0603787N	Special Processes	04	13,088					U
73	0603790N	NATO Research and Development	04	8,567	9,099	9,099			U
74	0603795N	Land Attack Technology	04	17,260	33,568	33,568		2,100	U
75	0603851M	Joint Non-Lethal Weapons Testing	04	26,760	29,873	29,873			U
76	0603860N	Joint Precision Approach and Landing Systems - Dem/Val	04	102,195	106,391	106,391			U
77	0603925N	Directed Energy and Electric Weapon Systems	04	34,039	107,310	107,310			U
78	0604014N	F/A -18 Infrared Search and Track (IRST)	04						U
79	0604027N	Digital Warfare Office	04						U
80	0604028N	Small and Medium Unmanned Undersea Vehicles	04						U

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64	0603724N	Navy Energy Program	04				25,623		25,623	U
65	0603725N	Facilities Improvement	04				2,837		2,837	U
66	0603734N	CHALK CORAL	04				245,143		245,143	U
67	0603739N	Navy Logistic Productivity	04				2,995		2,995	U
68	0603746N	RETRACT MAPLE	04				306,101		306,101	U
69	0603748N	LINK PLUMERIA	04				253,675		253,675	U
70	0603751N	RETRACT ELM	04				55,691		55,691	U
71	0603764N	LINK EVERGREEN	04				48,982		48,982	U
72	0603787N	Special Processes	04							U
73	0603790N	NATO Research and Development	04				9,099		9,099	U
74	0603795N	Land Attack Technology	04				35,668		35,668	U
75	0603851M	Joint Non-Lethal Weapons Testing	04				29,873		29,873	U
76	0603860N	Joint Precision Approach and Landing Systems - Dem/Val	04				106,391		106,391	U
77	0603925N	Directed Energy and Electric Weapon Systems	04				107,310		107,310	U
78	0604014N	F/A -18 Infrared Search and Track (IRST)	04							U
79	0604027N	Digital Warfare Office	04							U
80	0604028N	Small and Medium Unmanned Undersea Vehicles	04							U

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64	0603724N	Navy Energy Program	04	25,656		25,656	U
65	0603725N	Facilities Improvement	04	5,301		5,301	U
66	0603734N	CHALK CORAL	04	267,985		267,985	U
67	0603739N	Navy Logistic Productivity	04	4,059		4,059	U
68	0603746N	RETRACT MAPLE	04	377,878		377,878	U
69	0603748N	LINK PLUMERIA	04	381,770		381,770	U
70	0603751N	RETRACT ELM	04	60,535		60,535	U
71	0603764N	LINK EVERGREEN	04				U
72	0603787N	Special Processes	04				U
73	0603790N	NATO Research and Development	04	9,652		9,652	U
74	0603795N	Land Attack Technology	04	15,529	1,400	16,929	U
75	0603851M	Joint Non-Lethal Weapons Testing	04	27,581		27,581	U
76	0603860N	Joint Precision Approach and Landing Systems - Dem/Val	04	101,566		101,566	U
77	0603925N	Directed Energy and Electric Weapon Systems	04	223,344		223,344	U
78	0604014N	F/A -18 Infrared Search and Track (IRST)	04	108,700		108,700	U
79	0604027N	Digital Warfare Office	04	26,691		26,691	U
80	0604028N	Small and Medium Unmanned Undersea Vehicles	04	16,717		16,717	U

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81	0604029N	Unmanned Undersea Vehicle Core Technologies	04						U
82	0604030N	Rapid Prototyping, Experimentation and Demonstration.	04						U
83	0604031N	Large Unmanned Undersea Vehicles	04						U
84	0604112N	Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 - 80)	04	69,185	83,935	83,935			U
85	0604122N	Remote Minehunting System (RMS)	04	2,926					U
86	0604126N	Littoral Airborne MCM	04						U
87	0604127N	Surface Mine Countermeasures	04						U
88	0604272N	Tactical Air Directional Infrared Countermeasures (TADIRCM)	04	59,753	46,844	46,844	5,710	5,710	U
89	0604286M	Marine Corps Additive Manufacturing Technology Development	04		6,200	6,200			U
90	0604289M	Next Generation Logistics	04						U
91	0604292N	MH-XX	04	1,618					U
92	0604320M	Rapid Technology Capability Prototype	04		7,055	7,055			U
93	0604454N	LX (R)	04	24,730	9,578	9,578			U
94	0604536N	Advanced Undersea Prototyping	04	57,363	66,543	66,543			U
95	0604659N	Precision Strike Weapons Development Program	04	4,874	31,315	31,315			U
96	0604707N	Space and Electronic Warfare (SEW) Architecture/Engineering Support	04	20,104	42,851	42,851			U

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81	0604029N	Unmanned Undersea Vehicle Core Technologies	04							U
82	0604030N	Rapid Prototyping, Experimentation and Demonstration.	04							U
83	0604031N	Large Unmanned Undersea Vehicles	04							U
84	0604112N	Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 - 80)	04				83,935		83,935	U
85	0604122N	Remote Minehunting System (RMS)	04							U
86	0604126N	Littoral Airborne MCM	04							U
87	0604127N	Surface Mine Countermeasures	04							U
88	0604272N	Tactical Air Directional Infrared Countermeasures (TADIRCM)	04				52,554		52,554	U
89	0604286M	Marine Corps Additive Manufacturing Technology Development	04				6,200		6,200	U
90	0604289M	Next Generation Logistics	04							U
91	0604292N	MH-XX	04							U
92	0604320M	Rapid Technology Capability Prototype	04				7,055		7,055	U
93	0604454N	LX (R)	04				9,578		9,578	U
94	0604536N	Advanced Undersea Prototyping	04				66,543		66,543	U
95	0604659N	Precision Strike Weapons Development Program	04				31,315		31,315	U
96	0604707N	Space and Electronic Warfare (SEW) Architecture/Engineering Support	04				42,851		42,851	U

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81	0604029N	Unmanned Undersea Vehicle Core Technologies	04	30,187		30,187	U
82	0604030N	Rapid Prototyping, Experimentation and Demonstration.	04	48,796		48,796	U
83	0604031N	Large Unmanned Undersea Vehicles	04	92,613		92,613	U
84	0604112N	Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78 - 80)	04	58,121		58,121	U
85	0604122N	Remote Minehunting System (RMS)	04				U
86	0604126N	Littoral Airborne MCM	04	17,622		17,622	U
87	0604127N	Surface Mine Countermeasures	04	18,154		18,154	U
88	0604272N	Tactical Air Directional Infrared Countermeasures (TADIRCM)	04	47,278		47,278	U
89	0604286M	Marine Corps Additive Manufacturing Technology Development	04				U
90	0604289M	Next Generation Logistics	04	11,081		11,081	U
91	0604292N	MH-XX	04				U
92	0604320M	Rapid Technology Capability Prototype	04	7,107		7,107	U
93	0604454N	LX (R)	04	5,549		5,549	U
94	0604536N	Advanced Undersea Prototyping	04	87,669		87,669	U
95	0604659N	Precision Strike Weapons Development Program	04	132,818		132,818	U
96	0604707N	Space and Electronic Warfare (SEW) Architecture/Engineering Support	04	7,230		7,230	U

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97	0604786N	Offensive Anti-Surface Warfare Weapon Development	04	301,554	160,694	160,694			U
98	0605812M	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	04	7,658					U
99	0303354N	ASW Systems Development - MIP	04	9,110	8,278	8,278			U
100	0304240M	Advanced Tactical Unmanned Aircraft System	04		7,979	7,979			U
101	0304240N	Advanced Tactical Unmanned Aircraft System	04						U
102	0304270N	Electronic Warfare Development - MIP	04	437	527	527			U
		Advanced Component Development & Prototypes		4,510,800	4,218,714	4,193,714	27,710	59,510	
103	0603208N	Training System Aircraft	05	17,490	16,945	16,945			U
104	0604212N	Other Helo Development	05	5,889	26,786	26,786			U
105	0604214M	AV-8B Aircraft - Eng Dev	05						U
106	0604214N	AV-8B Aircraft - Eng Dev	05	32,179	48,780	48,780			U
107	0604215N	Standards Development	05	1,300	2,722	2,722			U
108	0604216N	Multi-Mission Helicopter Upgrade Development	05	5,189	5,371	5,371			U
109	0604218N	Air/Ocean Equipment Engineering	05	3,747	782	782			U
110	0604221N	P-3 Modernization Program	05	1,864	1,361	1,361			U
111	0604230N	Warfare Support System	05	11,404	14,167	14,167		5,400	U
112	0604231N	Tactical Command System	05	36,190	55,695	55,695			U

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Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests**	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
97	0604786N	Offensive Anti-Surface Warfare Weapon Development	04				160,694		160,694	U
98	0605812M	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	04							U
99	0303354N	ASW Systems Development - MIP	04				8,278		8,278	U
100	0304240M	Advanced Tactical Unmanned Aircraft System	04				7,979		7,979	U
101	0304240N	Advanced Tactical Unmanned Aircraft System	04							U
102	0304270N	Electronic Warfare Development - MIP	04				527		527	U
		Advanced Component Development & Prototypes					4,253,224		4,253,224	
103	0603208N	Training System Aircraft	05				16,945		16,945	U
104	0604212N	Other Helo Development	05				26,786		26,786	U
105	0604214M	AV-8B Aircraft - Eng Dev	05							U
106	0604214N	AV-8B Aircraft - Eng Dev	05				48,780		48,780	U
107	0604215N	Standards Development	05				2,722		2,722	U
108	0604216N	Multi-Mission Helicopter Upgrade Development	05				5,371		5,371	U
109	0604218N	Air/Ocean Equipment Engineering	05				782		782	U
110	0604221N	P-3 Modernization Program	05				1,361		1,361	U
111	0604230N	Warfare Support System	05				19,567		19,567	U
112	0604231N	Tactical Command System	05				55,695		55,695	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
97	0604786N	Offensive Anti-Surface Warfare Weapon Development	04	143,062		143,062	U
98	0605812M	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	04				U
99	0303354N	ASW Systems Development - MIP	04	8,889		8,889	U
100	0304240M	Advanced Tactical Unmanned Aircraft System	04	25,291		25,291	U
101	0304240N	Advanced Tactical Unmanned Aircraft System	04	9,300		9,300	U
102	0304270N	Electronic Warfare Development - MIP	04	466		466	U
		Advanced Component Development & Prototypes		4,293,713	33,300	4,327,013	
103	0603208N	Training System Aircraft	05	12,798		12,798	U
104	0604212N	Other Helo Development	05	32,128		32,128	U
105	0604214M	AV-8B Aircraft - Eng Dev	05	46,363		46,363	U
106	0604214N	AV-8B Aircraft - Eng Dev	05				U
107	0604215N	Standards Development	05	3,771		3,771	U
108	0604216N	Multi-Mission Helicopter Upgrade Development	05	16,611		16,611	U
109	0604218N	Air/Ocean Equipment Engineering	05	17,368		17,368	U
110	0604221N	P-3 Modernization Program	05	2,134		2,134	U
111	0604230N	Warfare Support System	05	9,729		9,729	U
112	0604231N	Tactical Command System	05	57,688		57,688	U

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113	0604234N	Advanced Hawkeye	05	354,390	292,535	292,535			U
114	0604245M	H-1 Upgrades	05						U
115	0604245N	H-1 Upgrades	05	27,013	61,288	61,288			U
116	0604261N	Acoustic Search Sensors	05	28,940	37,167	37,167			U
117	0604262N	V-22A	05	149,113	171,386	171,386			U
118	0604264N	Air Crew Systems Development	05	8,746	13,235	13,235			U
119	0604269N	EA-18	05	100,825	173,488	173,488			U
120	0604270N	Electronic Warfare Development	05	44,894	54,055	54,055			U
121	0604273M	Executive Helo Development	05						U
122	0604273N	Executive Helo Development	05	327,770	451,938	451,938			U
123	0604274N	Next Generation Jammer (NGJ)	05	559,017	632,936	632,936			U
124	0604280N	Joint Tactical Radio System - Navy (JTRS-Navy)	05	2,295	4,310	4,310			U
125	0604282N	Next Generation Jammer (NGJ) Increment II	05	18,964	66,686	66,686			U
126	0604307N	Surface Combatant Combat System Engineering	05	288,678	390,238	390,238			U
127	0604311N	LPD-17 Class Systems Integration	05	565	689	689			U
128	0604329N	Small Diameter Bomb (SDB)	05	86,989	112,846	112,846			U
129	0604366N	Standard Missile Improvements	05	113,601	158,578	158,578			U
130	0604373N	Airborne MCM	05	44,930	15,734	15,734			U

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113	0604234N	Advanced Hawkeye	05				292,535		292,535	U
114	0604245M	H-1 Upgrades	05							U
115	0604245N	H-1 Upgrades	05				61,288		61,288	U
116	0604261N	Acoustic Search Sensors	05				37,167		37,167	U
117	0604262N	V-22A	05				171,386		171,386	U
118	0604264N	Air Crew Systems Development	05				13,235		13,235	U
119	0604269N	EA-18	05				173,488		173,488	U
120	0604270N	Electronic Warfare Development	05				54,055		54,055	U
121	0604273M	Executive Helo Development	05							U
122	0604273N	Executive Helo Development	05				451,938		451,938	U
123	0604274N	Next Generation Jammer (NGJ)	05				632,936		632,936	U
124	0604280N	Joint Tactical Radio System - Navy (JTRS-Navy)	05				4,310		4,310	U
125	0604282N	Next Generation Jammer (NGJ) Increment II	05				66,686		66,686	U
126	0604307N	Surface Combatant Combat System Engineering	05				390,238		390,238	U
127	0604311N	LPD-17 Class Systems Integration	05				689		689	U
128	0604329N	Small Diameter Bomb (SDB)	05				112,846		112,846	U
129	0604366N	Standard Missile Improvements	05				158,578		158,578	U
130	0604373N	Airborne MCM	05				15,734		15,734	U

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113	0604234N	Advanced Hawkeye	05	223,565		223,565	U
114	0604245M	H-1 Upgrades	05	58,097		58,097	U
115	0604245N	H-1 Upgrades	05				U
116	0604261N	Acoustic Search Sensors	05	42,485		42,485	U
117	0604262N	V-22A	05	143,079		143,079	U
118	0604264N	Air Crew Systems Development	05	20,980		20,980	U
119	0604269N	EA-18	05	147,419		147,419	U
120	0604270N	Electronic Warfare Development	05	89,824		89,824	U
121	0604273M	Executive Helo Development	05	245,064		245,064	U
122	0604273N	Executive Helo Development	05				U
123	0604274N	Next Generation Jammer (NGJ)	05	459,529		459,529	U
124	0604280N	Joint Tactical Radio System - Navy (JTRS-Navy)	05	3,272		3,272	U
125	0604282N	Next Generation Jammer (NGJ) Increment II	05	115,253		115,253	U
126	0604307N	Surface Combatant Combat System Engineering	05	397,403		397,403	U
127	0604311N	LPD-17 Class Systems Integration	05	939		939	U
128	0604329N	Small Diameter Bomb (SDB)	05	104,448		104,448	U
129	0604366N	Standard Missile Improvements	05	165,881		165,881	U
130	0604373N	Airborne MCM	05	10,831		10,831	U

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131	0604378N	Naval Integrated Fire Control - Counter Air Systems Engineering	05	25,086	25,445	25,445			U
132	0604501N	Advanced Above Water Sensors	05	70,658	87,233	87,233			U
133	0604503N	SSN-688 and Trident Modernization	05	120,261	130,981	130,981			U
134	0604504N	Air Control	05	42,206	75,186	75,186			U
135	0604512N	Shipboard Aviation Systems	05	114,327	177,926	177,926			U
136	0604518N	Combat Information Center Conversion	05	6,092	8,062	8,062			U
137	0604522N	Air and Missile Defense Radar (AMDR) System	05	141,338	32,090	32,090			U
138	0604530N	Advanced Arresting Gear (AAG)	05						U
139	0604558N	New Design SSN	05	127,883	120,087	120,087			U
140	0604562N	Submarine Tactical Warfare System	05	50,069	50,850	50,850			U
141	0604567N	Ship Contract Design/ Live Fire T&E	05	82,946	67,166	67,166			U
142	0604574N	Navy Tactical Computer Resources	05	3,059	4,817	4,817			U
143	0604580N	Virginia Payload Module (VPM)	05	94,846	72,861	72,861			U
144	0604601N	Mine Development	05	14,860	25,635	25,635			U
145	0604610N	Lightweight Torpedo Development	05	29,567	28,076	28,076			U
146	0604654N	Joint Service Explosive Ordnance Development	05	7,369	7,561	7,561			U
147	0604703N	Personnel, Training, Simulation, and Human Factors	05	4,805	40,828	40,828			U
148	0604727N	Joint Standoff Weapon Systems	05	396	435	435			U

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131	0604378N	Naval Integrated Fire Control - Counter Air Systems Engineering	05				25,445		25,445	U
132	0604501N	Advanced Above Water Sensors	05				87,233		87,233	U
133	0604503N	SSN-688 and Trident Modernization	05				130,981		130,981	U
134	0604504N	Air Control	05				75,186		75,186	U
135	0604512N	Shipboard Aviation Systems	05				177,926		177,926	U
136	0604518N	Combat Information Center Conversion	05				8,062		8,062	U
137	0604522N	Air and Missile Defense Radar (AMDR) System	05				32,090		32,090	U
138	0604530N	Advanced Arresting Gear (AAG)	05							U
139	0604558N	New Design SSN	05				120,087		120,087	U
140	0604562N	Submarine Tactical Warfare System	05				50,850		50,850	U
141	0604567N	Ship Contract Design/ Live Fire T&E	05				67,166		67,166	U
142	0604574N	Navy Tactical Computer Resources	05				4,817		4,817	U
143	0604580N	Virginia Payload Module (VPM)	05				72,861		72,861	U
144	0604601N	Mine Development	05				25,635		25,635	U
145	0604610N	Lightweight Torpedo Development	05				28,076		28,076	U
146	0604654N	Joint Service Explosive Ordnance Development	05				7,561		7,561	U
147	0604703N	Personnel, Training, Simulation, and Human Factors	05				40,828		40,828	U
148	0604727N	Joint Standoff Weapon Systems	05				435		435	U

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131	0604378N	Naval Integrated Fire Control - Counter Air Systems Engineering	05	33,429		33,429	U
132	0604501N	Advanced Above Water Sensors	05	35,635		35,635	U
133	0604503N	SSN-688 and Trident Modernization	05	126,932		126,932	U
134	0604504N	Air Control	05	62,448		62,448	U
135	0604512N	Shipboard Aviation Systems	05	9,710		9,710	U
136	0604518N	Combat Information Center Conversion	05	19,303		19,303	U
137	0604522N	Air and Missile Defense Radar (AMDR) System	05	27,059		27,059	U
138	0604530N	Advanced Arresting Gear (AAG)	05	184,106		184,106	U
139	0604558N	New Design SSN	05	148,233		148,233	U
140	0604562N	Submarine Tactical Warfare System	05	60,824		60,824	U
141	0604567N	Ship Contract Design/ Live Fire T&E	05	60,062		60,062	U
142	0604574N	Navy Tactical Computer Resources	05	4,642		4,642	U
143	0604580N	Virginia Payload Module (VPM)	05				U
144	0604601N	Mine Development	05	25,756		25,756	U
145	0604610N	Lightweight Torpedo Development	05	95,147		95,147	U
146	0604654N	Joint Service Explosive Ordnance Development	05	7,107		7,107	U
147	0604703N	Personnel, Training, Simulation, and Human Factors	05	6,539		6,539	U
148	0604727N	Joint Standoff Weapon Systems	05	441		441	U

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149	0604755N	Ship Self Defense (Detect & Control)	05	133,452	161,713	161,713			U
150	0604756N	Ship Self Defense (Engage: Hard Kill)	05	115,081	212,412	212,412			U
151	0604757N	Ship Self Defense (Engage: Soft Kill/EW)	05	108,630	103,391	103,391			U
152	0604761N	Intelligence Engineering	05	9,029	34,855	34,855			U
153	0604771N	Medical Development	05	24,510	9,353	9,353			U
154	0604777N	Navigation/ID System	05	41,905	92,546	92,546			U
155	0604800M	Joint Strike Fighter (JSF) - EMD	05	519,393	152,934	152,934			U
156	0604800N	Joint Strike Fighter (JSF) - EMD	05	512,662	108,931	108,931			U
157	0604810M	Joint Strike Fighter Follow On Modernization (FoM) - Marine Corps	05	29,691	144,958	144,958			U
158	0604810N	Joint Strike Fighter Follow On Modernization (FoM) - Navy	05	25,041	143,855	143,855			U
159	0605013M	Information Technology Development	05	3,744	14,865	14,865			U
160	0605013N	Information Technology Development	05	87,469	152,977	152,977			U
161	0605024N	Anti-Tamper Technology Support	05	500	3,410	3,410			U
162	0605212M	CH-53K RDTE	05						U
163	0605212N	CH-53K RDTE	05	339,101	340,758	340,758			U
164	0605215N	Mission Planning	05	32,876	33,430	33,430			U
165	0605217N	Common Avionics	05	42,711	58,163	58,163			U
166	0605220N	Ship to Shore Connector (SSC)	05	12,588	22,410	22,410			U

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149	0604755N	Ship Self Defense (Detect & Control)	05				161,713		161,713	U
150	0604756N	Ship Self Defense (Engage: Hard Kill)	05				212,412		212,412	U
151	0604757N	Ship Self Defense (Engage: Soft Kill/EW)	05				103,391		103,391	U
152	0604761N	Intelligence Engineering	05				34,855		34,855	U
153	0604771N	Medical Development	05				9,353		9,353	U
154	0604777N	Navigation/ID System	05				92,546		92,546	U
155	0604800M	Joint Strike Fighter (JSF) - EMD	05				152,934		152,934	U
156	0604800N	Joint Strike Fighter (JSF) - EMD	05				108,931		108,931	U
157	0604810M	Joint Strike Fighter Follow On Modernization (FoM) - Marine Corps	05				144,958		144,958	U
158	0604810N	Joint Strike Fighter Follow On Modernization (FoM) - Navy	05				143,855		143,855	U
159	0605013M	Information Technology Development	05				14,865		14,865	U
160	0605013N	Information Technology Development	05				152,977		152,977	U
161	0605024N	Anti-Tamper Technology Support	05				3,410		3,410	U
162	0605212M	CH-53K RDTE	05							U
163	0605212N	CH-53K RDTE	05				340,758		340,758	U
164	0605215N	Mission Planning	05				33,430		33,430	U
165	0605217N	Common Avionics	05				58,163		58,163	U
166	0605220N	Ship to Shore Connector (SSC)	05				22,410		22,410	U

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149	0604755N	Ship Self Defense (Detect & Control)	05	180,391	1,100	181,491	U
150	0604756N	Ship Self Defense (Engage: Hard Kill)	05	178,538		178,538	U
151	0604757N	Ship Self Defense (Engage: Soft Kill/EW)	05	120,507		120,507	U
152	0604761N	Intelligence Engineering	05	29,715		29,715	U
153	0604771N	Medical Development	05	8,095		8,095	U
154	0604777N	Navigation/ID System	05	121,026		121,026	U
155	0604800M	Joint Strike Fighter (JSF) - EMD	05	66,566		66,566	U
156	0604800N	Joint Strike Fighter (JSF) - EMD	05	65,494		65,494	U
157	0604810M	Joint Strike Fighter Follow On Modernization (FoM) - Marine Corps	05				U
158	0604810N	Joint Strike Fighter Follow On Modernization (FoM) - Navy	05				U
159	0605013M	Information Technology Development	05	14,005		14,005	U
160	0605013N	Information Technology Development	05	268,567		268,567	U
161	0605024N	Anti-Tamper Technology Support	05	5,618		5,618	U
162	0605212M	CH-53K RDTE	05	326,945		326,945	U
163	0605212N	CH-53K RDTE	05				U
164	0605215N	Mission Planning	05	32,714		32,714	U
165	0605217N	Common Avionics	05	51,486		51,486	U
166	0605220N	Ship to Shore Connector (SSC)	05	1,444		1,444	U

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167	0605327N	T-AO 205 Class	05	1,062	1,961	1,961			U
168	0605414N	Unmanned Carrier Aviation (UCA)	05	75,863	222,208	222,208			U
169	0605450M	Joint Air-to-Ground Missile (JAGM)	05						U
170	0605450N	Joint Air-to-Ground Missile (JAGM)	05	17,834	15,473	15,473			U
171	0605500N	Multi-mission Maritime Aircraft (MMA)	05	61,959	11,795	11,795			U
172	0605504N	Multi-Mission Maritime (MMA) Increment III	05	109,827	181,731	181,731			U
173	0605611M	Marine Corps Assault Vehicles System Development & Demonstration	05		178,993	178,993			U
174	0605813M	Joint Light Tactical Vehicle (JLTV) System Development & Demonstration	05		20,710	20,710			U
175	0204202N	DDG-1000	05	45,187	140,500	140,500			U
176	0303267N	Auctioned Spectrum Relocation Fund***	05	251,203					U
177	0303367N	Spectrum Access Research and Development***	05	46,902					U
178	0303467N	SENSR Spectrum Pipeline SRF***	05	150					U
179	0304231N	Tactical Command System - MIP	05	676					U
180	0304785N	Tactical Cryptologic Systems	05	34,038	28,311	28,311			U
181	0305124N	Special Applications Program	05	35,002					U
182	0306250M	Cyber Operations Technology Development	05	2,349	4,502	4,502			U
		System Development & Demonstration		5,928,185	6,362,102	6,362,102		5,400	

***Funding in this Program Element 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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Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
167	0605327N	T-AO 205 Class	05				1,961		1,961	U
168	0605414N	Unmanned Carrier Aviation (UCA)	05				222,208		222,208	U
169	0605450M	Joint Air-to-Ground Missile (JAGM)	05							U
170	0605450N	Joint Air-to-Ground Missile (JAGM)	05				15,473		15,473	U
171	0605500N	Multi-mission Maritime Aircraft (MMA)	05				11,795		11,795	U
172	0605504N	Multi-Mission Maritime (MMA) Increment III	05				181,731		181,731	U
173	0605611M	Marine Corps Assault Vehicles System Development & Demonstration	05				178,993		178,993	U
174	0605813M	Joint Light Tactical Vehicle (JLTV) System Development & Demonstration	05				20,710		20,710	U
175	0204202N	DDG-1000	05				140,500		140,500	U
176	0303267N	Auctioned Spectrum Relocation Fund***	05							U
177	0303367N	Spectrum Access Research and Development***	05							U
178	0303467N	SENSR Spectrum Pipeline SRF***	05							U
179	0304231N	Tactical Command System - MIP	05							U
180	0304785N	Tactical Cryptologic Systems	05				28,311		28,311	U
181	0305124N	Special Applications Program	05							U
182	0306250M	Cyber Operations Technology Development	05				4,502		4,502	U
		System Development & Demonstration					6,367,502		6,367,502	

***Funding in this Program Element 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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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
167	0605327N	T-AO 205 Class	05	1,298		1,298	U
168	0605414N	Unmanned Carrier Aviation (UCA)	05	718,942		718,942	U
169	0605450M	Joint Air-to-Ground Missile (JAGM)	05	6,759		6,759	U
170	0605450N	Joint Air-to-Ground Missile (JAGM)	05				U
171	0605500N	Multi-mission Maritime Aircraft (MMA)	05	37,296		37,296	U
172	0605504N	Multi-Mission Maritime (MMA) Increment III	05	160,389		160,389	U
173	0605611M	Marine Corps Assault Vehicles System Development & Demonstration	05	98,223		98,223	U
174	0605813M	Joint Light Tactical Vehicle (JLTV) System Development & Demonstration	05	2,260		2,260	U
175	0204202N	DDG-1000	05	161,264		161,264	U
176	0303267N	Auctioned Spectrum Relocation Fund***	05				U
177	0303367N	Spectrum Access Research and Development***	05				U
178	0303467N	SENSR Spectrum Pipeline SRF***	05				U
179	0304231N	Tactical Command System - MIP	05				U
180	0304785N	Tactical Cryptologic Systems	05	44,098		44,098	U
181	0305124N	Special Applications Program	05				U
182	0306250M	Cyber Operations Technology Development	05	6,808		6,808	U
		System Development & Demonstration		6,042,480	1,100	6,043,580	

***Funding in this Program Element 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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Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
183	0604256N	Threat Simulator Development	06	16,581	91,819	91,819			U
184	0604258N	Target Systems Development	06	34,021	23,053	23,053			U
185	0604759N	Major T&E Investment	06	51,375	52,634	52,634			U
186	0605126N	Joint Theater Air and Missile Defense Organization	06	2,888	141	141			U
187	0605152N	Studies and Analysis Support - Navy	06	3,861	3,917	3,917			U
188	0605154N	Center for Naval Analyses	06	43,532	50,432	50,432			U
189	0605285N	Next Generation Fighter	06	1,394					U
190	0605502N	Small Business Innovative Research	06	370,665					U
191	0605804N	Technical Information Services	06	1,494	782	782			U
192	0605853N	Management, Technical & International Support	06	97,939	94,562	94,562			U
193	0605856N	Strategic Technical Support	06	3,460	4,313	4,313			U
194	0605861N	RDT&E Science and Technology Management	06	62,961	1,104	1,104			U
195	0605863N	RDT&E Ship and Aircraft Support	06	105,693	105,666	105,666			U
196	0605864N	Test and Evaluation Support	06	398,972	373,667	373,667			U
197	0605865N	Operational Test and Evaluation Capability	06	17,984	20,298	20,298			U
198	0605866N	Navy Space and Electronic Warfare (SEW) Support	06	9,658	17,341	17,341			U
199	0605867N	SEW Surveillance/Reconnaissance Support	06	6,500					U

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183	0604256N	Threat Simulator Development	06				91,819		91,819	U
184	0604258N	Target Systems Development	06				23,053		23,053	U
185	0604759N	Major T&E Investment	06				52,634		52,634	U
186	0605126N	Joint Theater Air and Missile Defense Organization	06				141		141	U
187	0605152N	Studies and Analysis Support - Navy	06				3,917		3,917	U
188	0605154N	Center for Naval Analyses	06				50,432		50,432	U
189	0605285N	Next Generation Fighter	06							U
190	0605502N	Small Business Innovative Research	06							U
191	0605804N	Technical Information Services	06				782		782	U
192	0605853N	Management, Technical & International Support	06				94,562		94,562	U
193	0605856N	Strategic Technical Support	06				4,313		4,313	U
194	0605861N	RDT&E Science and Technology Management	06				1,104		1,104	U
195	0605863N	RDT&E Ship and Aircraft Support	06				105,666		105,666	U
196	0605864N	Test and Evaluation Support	06				373,667		373,667	U
197	0605865N	Operational Test and Evaluation Capability	06				20,298		20,298	U
198	0605866N	Navy Space and Electronic Warfare (SEW) Support	06				17,341		17,341	U
199	0605867N	SEW Surveillance/Reconnaissance Support	06							U

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183	0604256N	Threat Simulator Development	06	94,576		94,576	U
184	0604258N	Target Systems Development	06	10,981		10,981	U
185	0604759N	Major T&E Investment	06	77,014		77,014	U
186	0605126N	Joint Theater Air and Missile Defense Organization	06	48		48	U
187	0605152N	Studies and Analysis Support - Navy	06	3,942		3,942	U
188	0605154N	Center for Naval Analyses	06	48,797		48,797	U
189	0605285N	Next Generation Fighter	06	5,000		5,000	U
190	0605502N	Small Business Innovative Research	06				U
191	0605804N	Technical Information Services	06	1,029		1,029	U
192	0605853N	Management, Technical & International Support	06	87,565		87,565	U
193	0605856N	Strategic Technical Support	06	4,231		4,231	U
194	0605861N	RDT&E Science and Technology Management	06	1,072		1,072	U
195	0605863N	RDT&E Ship and Aircraft Support	06	97,471		97,471	U
196	0605864N	Test and Evaluation Support	06	373,834		373,834	U
197	0605865N	Operational Test and Evaluation Capability	06	21,554		21,554	U
198	0605866N	Navy Space and Electronic Warfare (SEW) Support	06	16,227		16,227	U
199	0605867N	SEW Surveillance/Reconnaissance Support	06				U

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200	0605873M	Marine Corps Program Wide Support	06	19,142	21,751	21,751			U
201	0605898N	Management HQ - R&D	06	16,188	44,279	44,279			U
202	0606355N	Warfare Innovation Management	06	14,846	28,841	28,841			U
203	0606942M	Assessments and Evaluations Cyber Vulnerabilities	06						U
204	0606942N	Assessments and Evaluations Cyber Vulnerabilities	06						U
205	0305327N	Insider Threat	06						U
206	0902498N	Management Headquarters (Departmental Support Activities)	06		1,749	1,749			U
207	0909999N	Financing for Cancelled Account Adjustments	06	136					U
208	1206867N	SEW Surveillance/Reconnaissance Support	06		9,408	9,408			U
		Management Support		1,279,290	945,757	945,757			
210	0604227N	HARPOON Modifications	07						U
211	0604840M	F-35 C2D2	07						U
212	0604840N	F-35 C2D2	07						U
213	0607658N	Cooperative Engagement Capability (CEC)	07	75,099	92,571	92,571			U
214	0607700N	Deployable Joint Command and Control	07	2,935	3,137	3,137			U
215	0101221N	Strategic Sub & Weapons System Support	07	130,364	135,219	135,219			U

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200	0605873M	Marine Corps Program Wide Support	06				21,751		21,751	U
201	0605898N	Management HQ - R&D	06				44,279		44,279	U
202	0606355N	Warfare Innovation Management	06				28,841		28,841	U
203	0606942M	Assessments and Evaluations Cyber Vulnerabilities	06							U
204	0606942N	Assessments and Evaluations Cyber Vulnerabilities	06							U
205	0305327N	Insider Threat	06							U
206	0902498N	Management Headquarters (Departmental Support Activities)	06				1,749		1,749	U
207	0909999N	Financing for Cancelled Account Adjustments	06							U
208	1206867N	SEW Surveillance/Reconnaissance Support	06				9,408		9,408	U
		Management Support					945,757		945,757	
210	0604227N	HARPOON Modifications	07							U
211	0604840M	F-35 C2D2	07							U
212	0604840N	F-35 C2D2	07							U
213	0607658N	Cooperative Engagement Capability (CEC)	07				92,571		92,571	U
214	0607700N	Deployable Joint Command and Control	07				3,137		3,137	U
215	0101221N	Strategic Sub & Weapons System Support	07				135,219		135,219	U

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200	0605873M	Marine Corps Program Wide Support	06	24,303		24,303	U
201	0605898N	Management HQ - R&D	06	43,262		43,262	U
202	0606355N	Warfare Innovation Management	06	41,918		41,918	U
203	0606942M	Assessments and Evaluations Cyber Vulnerabilities	06	7,000		7,000	U
204	0606942N	Assessments and Evaluations Cyber Vulnerabilities	06	48,800		48,800	U
205	0305327N	Insider Threat	06	1,682		1,682	U
206	0902498N	Management Headquarters (Departmental Support Activities)	06	1,579		1,579	U
207	0909999N	Financing for Cancelled Account Adjustments	06				U
208	1206867N	SEW Surveillance/Reconnaissance Support	06	8,684		8,684	U
		Management Support		1,020,569		1,020,569	
210	0604227N	HARPOON Modifications	07	5,426		5,426	U
211	0604840M	F-35 C2D2	07	259,122		259,122	U
212	0604840N	F-35 C2D2	07	252,360		252,360	U
213	0607658N	Cooperative Engagement Capability (CEC)	07	130,515		130,515	U
214	0607700N	Deployable Joint Command and Control	07	3,127		3,127	U
215	0101221N	Strategic Sub & Weapons System Support	07	157,679		157,679	U

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216	0101224N	SSBN Security Technology Program	07	32,910	36,242	36,242			U
217	0101226N	Submarine Acoustic Warfare Development	07	7,300	12,053	12,053			U
218	0101402N	Navy Strategic Communications	07	16,753	18,221	18,221			U
219	0204136N	F/A-18 Squadrons	07	169,473	224,470	224,470			U
220	0204163N	Fleet Telecommunications (Tactical)	07	38,949	33,525	33,525			U
221	0204228N	Surface Support	07	20,595	24,829	24,829			U
222	0204229N	Tomahawk and Tomahawk Mission Planning Center (TMPC)	07	49,149	133,617	133,617			U
223	0204311N	Integrated Surveillance System	07	57,043	38,972	38,972	11,600	11,600	U
224	0204313N	Ship-Towed Array Surveillance Systems	07						U
225	0204413N	Amphibious Tactical Support Units (Displacement Craft)	07	11,143	3,940	3,940			U
226	0204460M	Ground/Air Task Oriented Radar (G/ATOR)	07	78,860	54,645	54,645			U
227	0204571N	Consolidated Training Systems Development	07	44,435	66,518	66,518			U
228	0204574N	Cryptologic Direct Support	07	1,122	1,155	1,155	1,200	1,200	U
229	0204575N	Electronic Warfare (EW) Readiness Support	07	79,410	51,040	51,040			U
230	0205601N	HARM Improvement	07	32,889	87,989	87,989			U
231	0205604N	Tactical Data Links	07	121,396	89,852	89,852			U

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216	0101224N	SSBN Security Technology Program	07				36,242		36,242	U
217	0101226N	Submarine Acoustic Warfare Development	07				12,053		12,053	U
218	0101402N	Navy Strategic Communications	07				18,221		18,221	U
219	0204136N	F/A-18 Squadrons	07				224,470		224,470	U
220	0204163N	Fleet Telecommunications (Tactical)	07				33,525		33,525	U
221	0204228N	Surface Support	07				24,829		24,829	U
222	0204229N	Tomahawk and Tomahawk Mission Planning Center (TMPC)	07				133,617		133,617	U
223	0204311N	Integrated Surveillance System	07				50,572		50,572	U
224	0204313N	Ship-Towed Array Surveillance Systems	07							U
225	0204413N	Amphibious Tactical Support Units (Displacement Craft)	07				3,940		3,940	U
226	0204460M	Ground/Air Task Oriented Radar (G/ATOR)	07				54,645		54,645	U
227	0204571N	Consolidated Training Systems Development	07				66,518		66,518	U
228	0204574N	Cryptologic Direct Support	07				2,355		2,355	U
229	0204575N	Electronic Warfare (EW) Readiness Support	07				51,040		51,040	U
230	0205601N	HARM Improvement	07				87,989		87,989	U
231	0205604N	Tactical Data Links	07				89,852		89,852	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
216	0101224N	SSBN Security Technology Program	07	43,198		43,198	U
217	0101226N	Submarine Acoustic Warfare Development	07	11,311		11,311	U
218	0101402N	Navy Strategic Communications	07	39,313		39,313	U
219	0204136N	F/A-18 Squadrons	07	193,086		193,086	U
220	0204163N	Fleet Telecommunications (Tactical)	07	25,014		25,014	U
221	0204228N	Surface Support	07	11,661		11,661	U
222	0204229N	Tomahawk and Tomahawk Mission Planning Center (TMPC)	07	282,395		282,395	U
223	0204311N	Integrated Surveillance System	07	36,959		36,959	U
224	0204313N	Ship-Towed Array Surveillance Systems	07	15,454		15,454	U
225	0204413N	Amphibious Tactical Support Units (Displacement Craft)	07	6,073		6,073	U
226	0204460M	Ground/Air Task Oriented Radar (G/ATOR)	07	45,029		45,029	U
227	0204571N	Consolidated Training Systems Development	07	104,903		104,903	U
228	0204574N	Cryptologic Direct Support	07	4,544		4,544	U
229	0204575N	Electronic Warfare (EW) Readiness Support	07	66,889		66,889	U
230	0205601N	HARM Improvement	07	120,762		120,762	U
231	0205604N	Tactical Data Links	07	104,696		104,696	U

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232	0205620N	Surface ASW Combat System Integration	07	23,779	29,351	29,351			U
233	0205632N	MK-48 ADCAP	07	48,507	68,553	68,553			U
234	0205633N	Aviation Improvements	07	121,138	119,099	119,099			U
235	0205675N	Operational Nuclear Power Systems	07	101,786	127,445	127,445			U
236	0206313M	Marine Corps Communications Systems	07	141,171	123,825	123,825			U
237	0206335M	Common Aviation Command and Control System (CAC2S)	07	6,934	7,343	7,343			U
238	0206623M	Marine Corps Ground Combat/ Supporting Arms Systems	07	45,877	66,009	66,009			U
239	0206624M	Marine Corps Combat Services Support	07	11,639	25,258	25,258			U
240	0206625M	USMC Intelligence/Electronic Warfare Systems (MIP)	07	22,978	30,886	30,886			U
241	0206629M	Amphibious Assault Vehicle	07	36,571	58,728	58,728			U
242	0207161N	Tactical AIM Missiles	07	54,678	42,884	42,884			U
243	0207163N	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07	34,010	25,364	25,364			U
244	0219902M	Global Combat Support System - Marine Corps (GCSS-MC)	07	9,128					U
248	0303109N	Satellite Communications (SPACE)	07	30,826					U
249	0303138N	Consolidated Afloat Network Enterprise Services (CANES)	07	23,224	24,271	24,271			U
250	0303140N	Information Systems Security Program	07	32,708	50,269	50,269			U

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232	0205620N	Surface ASW Combat System Integration	07				29,351		29,351	U
233	0205632N	MK-48 ADCAP	07				68,553		68,553	U
234	0205633N	Aviation Improvements	07				119,099		119,099	U
235	0205675N	Operational Nuclear Power Systems	07				127,445		127,445	U
236	0206313M	Marine Corps Communications Systems	07				123,825		123,825	U
237	0206335M	Common Aviation Command and Control System (CAC2S)	07				7,343		7,343	U
238	0206623M	Marine Corps Ground Combat/ Supporting Arms Systems	07				66,009		66,009	U
239	0206624M	Marine Corps Combat Services Support	07				25,258		25,258	U
240	0206625M	USMC Intelligence/Electronic Warfare Systems (MIP)	07				30,886		30,886	U
241	0206629M	Amphibious Assault Vehicle	07				58,728		58,728	U
242	0207161N	Tactical AIM Missiles	07				42,884		42,884	U
243	0207163N	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07				25,364		25,364	U
244	0219902M	Global Combat Support System - Marine Corps (GCSS-MC)	07							U
248	0303109N	Satellite Communications (SPACE)	07							U
249	0303138N	Consolidated Afloat Network Enterprise Services (CANES)	07				24,271		24,271	U
250	0303140N	Information Systems Security Program	07				50,269		50,269	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
232	0205620N	Surface ASW Combat System Integration	07	28,421		28,421	U
233	0205632N	MK-48 ADCAP	07	94,155		94,155	U
234	0205633N	Aviation Improvements	07	121,805		121,805	U
235	0205675N	Operational Nuclear Power Systems	07	117,028		117,028	U
236	0206313M	Marine Corps Communications Systems	07	174,779	16,130	190,909	U
237	0206335M	Common Aviation Command and Control System (CAC2S)	07	4,826		4,826	U
238	0206623M	Marine Corps Ground Combat/ Supporting Arms Systems	07	97,152		97,152	U
239	0206624M	Marine Corps Combat Services Support	07	30,156		30,156	U
240	0206625M	USMC Intelligence/Electronic Warfare Systems (MIP)	07	39,976		39,976	U
241	0206629M	Amphibious Assault Vehicle	07	22,637		22,637	U
242	0207161N	Tactical AIM Missiles	07	40,121		40,121	U
243	0207163N	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07	32,473		32,473	U
244	0219902M	Global Combat Support System - Marine Corps (GCSS-MC)	07				U
248	0303109N	Satellite Communications (SPACE)	07				U
249	0303138N	Consolidated Afloat Network Enterprise Services (CANES)	07	23,697		23,697	U
250	0303140N	Information Systems Security Program	07	44,228		44,228	U

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
252	0305192N	Military Intelligence Program (MIP) Activities	07	6,019	6,352	6,352			U
253	0305204N	Tactical Unmanned Aerial Vehicles	07	8,436	7,770	7,770			U
254	0305205N	UAS Integration and Interoperability	07	21,543	39,736	39,736			U
255	0305208M	Distributed Common Ground/Surface Systems	07	2,079	12,867	12,867			U
256	0305208N	Distributed Common Ground/Surface Systems	07	44,564	46,150	46,150			U
257	0305220N	MQ-4C Triton	07	113,606	84,115	84,115			U
258	0305231N	MQ-8 UAV	07	26,518	62,656	62,656			U
259	0305232M	RQ-11 UAV	07		2,022	2,022			U
260	0305234N	Small (Level 0) Tactical UAS (STUASL0)	07	5,071	4,835	4,835			U
261	0305239M	RQ-21A	07	8,379	8,899	8,899			U
262	0305241N	Multi-Intelligence Sensor Development	07	64,765	99,020	99,020			U
263	0305242M	Unmanned Aerial Systems (UAS) Payloads (MIP)	07	11,181	18,578	18,578			U
264	0305421N	RQ-4 Modernization	07	144,477	229,404	229,404			U
265	0308601N	Modeling and Simulation Support	07	4,529	5,238	5,238			U
266	0702207N	Depot Maintenance (Non-IF)	07	37,089	38,227	38,227			U
267	0708730N	Maritime Technology (MARITECH)	07	3,080	4,808	4,808			U

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

Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests**	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
252	0305192N	Military Intelligence Program (MIP) Activities	07				6,352		6,352	U
253	0305204N	Tactical Unmanned Aerial Vehicles	07				7,770		7,770	U
254	0305205N	UAS Integration and Interoperability	07				39,736		39,736	U
255	0305208M	Distributed Common Ground/Surface Systems	07				12,867		12,867	U
256	0305208N	Distributed Common Ground/Surface Systems	07				46,150		46,150	U
257	0305220N	MQ-4C Triton	07				84,115		84,115	U
258	0305231N	MQ-8 UAV	07				62,656		62,656	U
259	0305232M	RQ-11 UAV	07				2,022		2,022	U
260	0305234N	Small (Level 0) Tactical UAS (STUASL0)	07				4,835		4,835	U
261	0305239M	RQ-21A	07				8,899		8,899	U
262	0305241N	Multi-Intelligence Sensor Development	07				99,020		99,020	U
263	0305242M	Unmanned Aerial Systems (UAS) Payloads (MIP)	07				18,578		18,578	U
264	0305421N	RQ-4 Modernization	07				229,404		229,404	U
265	0308601N	Modeling and Simulation Support	07				5,238		5,238	U
266	0702207N	Depot Maintenance (Non-IF)	07				38,227		38,227	U
267	0708730N	Maritime Technology (MARITECH)	07				4,808		4,808	U

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

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
252	0305192N	Military Intelligence Program (MIP) Activities	07	6,081		6,081	U
253	0305204N	Tactical Unmanned Aerial Vehicles	07	8,529		8,529	U
254	0305205N	UAS Integration and Interoperability	07	41,212		41,212	U
255	0305208M	Distributed Common Ground/Surface Systems	07	7,687		7,687	U
256	0305208N	Distributed Common Ground/Surface Systems	07	42,846		42,846	U
257	0305220N	MQ-4C Triton	07	14,395		14,395	U
258	0305231N	MQ-8 UAV	07	9,843		9,843	U
259	0305232M	RQ-11 UAV	07	524		524	U
260	0305234N	Small (Level 0) Tactical UAS (STUASL0)	07	5,360		5,360	U
261	0305239M	RQ-21A	07	10,914		10,914	U
262	0305241N	Multi-Intelligence Sensor Development	07	81,231		81,231	U
263	0305242M	Unmanned Aerial Systems (UAS) Payloads (MIP)	07	5,956		5,956	U
264	0305421N	RQ-4 Modernization	07	219,894		219,894	U
265	0308601N	Modeling and Simulation Support	07	7,097		7,097	U
266	0702207N	Depot Maintenance (Non-IF)	07	36,560		36,560	U
267	0708730N	Maritime Technology (MARITECH)	07	7,284		7,284	U

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
268	1203109N	Satellite Communications (SPACE)	07		37,836	37,836			U
9999	9999999999	Classified Programs		1,602,086	1,364,347	1,364,347	89,855	89,855	U
		Operational Systems Development		3,818,201	3,980,140	3,980,140	102,655	102,655	
269	0901560N	Continuing Resolution Programs	20		-558,059	-558,059	196,172	158,972	U
		Undistributed			-558,059	-558,059	196,172	158,972	
Total Research, Development, Test & Eval, Navy				17,851,955	17,116,976	17,091,976	326,537	326,537	

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

Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
268	1203109N	Satellite Communications (SPACE)	07				37,836		37,836	U
9999	9999999999	Classified Programs		60,000	-60,000		1,514,202	-60,000	1,454,202	U
		Operational Systems Development					4,142,795		4,082,795	
269	0901560N	Continuing Resolution Programs	20				-399,087		-399,087	U
		Undistributed					-399,087		-399,087	
Total Research, Development, Test & Eval, Navy							17,478,513		17,418,513	

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

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
268	1203109N	Satellite Communications (SPACE)	07	39,174		39,174	U
9999	9999999999	Classified Programs		1,518,903	147,882	1,666,785	U
		Operational Systems Development		4,854,460	164,012	5,018,472	
269	0901560N	Continuing Resolution Programs	20				U
		Undistributed					
Total Research, Development, Test & Eval, Navy				18,451,066	198,412	18,649,478	

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Summary Recap of Budget Activities	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Research and Development	7,237	18,622	18,622		
Total Research, Development, Test & Evaluation	7,237	18,622	18,622		

Summary Recap of Non-RDT&E Title FYDP Programs

Mobility Forces	7,237	18,622	18,622		
Total Research, Development, Test & Evaluation	7,237	18,622	18,622		

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Summary Recap of Budget Activities	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
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

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Summary Recap of Budget Activities	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research and Development			
Total Research, Development, Test & Evaluation			
Summary Recap of Non-RDT&E Title FYDP Programs			
Mobility Forces			
Total Research, Development, Test & Evaluation			

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Appropriation: 4557N National Defense Sealift Fund

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
1	0408042N	National Defense Sealift Fund	04	7,237	18,622	18,622			U
		Research and Development		7,237	18,622	18,622			
Total National Defense Sealift Fund				7,237	18,622	18,622			

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Appropriation: 4557N National Defense Sealift Fund

Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
1	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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(Dollars in Thousands)

Appropriation: 4557N National Defense Sealift Fund

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
1	0408042N	National Defense Sealift Fund	04				U
				----------	----------	----------	
		Research and Development					
				----------	----------	----------	
Total National Defense Sealift Fund							

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Navy Logistic Productivity	0603739N	67	04	Volume 2 - 869
Navy Space & Electr Warfare Supt	0605866N	198	06	Volume 4 - 221
Navy Strategic Comms	0101402N	218	07	Volume 5 - 117
Navy Tactical Computer Resources	0604574N	142	05	Volume 3 - 939
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Next Generation Jammer (NGJ)	0604274N	123	05	Volume 3 - 467
Ocean Engineering Tech Dev	0603713N	62	04	Volume 2 - 741
Ocean Wrfghtg Env Applied Res	0602435N	10	02	Volume 1 - 167
Operational Nuclear Power Sys	0205675N	235	07	Volume 5 - 587
Operational Test & Eval Capability	0605865N	197	06	Volume 4 - 215
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Power Proj Applied Research	0602114N	4	02	Volume 1 - 61
Power Projection Advanced Technology	0603114N	18	03	Volume 1 - 253
RDT&E Science & Tech Mgmt	0605861N	194	06	Volume 4 - 165
RDT&E Ship & Aircraft Support	0605863N	195	06	Volume 4 - 175
RQ-11 UAV	0305232M	259	07	Volume 5 - 1205
Radiological Control	0603542N	43	04	Volume 2 - 315
Rapid Prototyping, Experimentation and Demonstrati	0604030N	82	04	Volume 2 - 1053
Rapid Technology Capability Prototype	0604320M	92	04	Volume 2 - 1183
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Ship Contract Design/ Live Fire T&E	0604567N	141	05	Volume 3 - 885
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Ship Self Def (Detect & Cntrl)	0604755N	149	05	Volume 3 - 1037
Ship Self Def (Engage: Hard Kill)	0604756N	150	05	Volume 3 - 1089
Ship Self Def (Engage: Soft Kill/EW)	0604757N	151	05	Volume 3 - 1133
Shipboard Aviation Systems	0604512N	135	05	Volume 3 - 775
Small Business Innovative Research	0605502N	190	06	Volume 4 - 63
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Small and Medium Unmanned Undersea Vehicles	0604028N	80	04	Volume 2 - 1023
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Standards Development	0604215N	107	05	Volume 3 - 71
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Submarine Tactical Warfare Sys	0603562N	46	04	Volume 2 - 405
Submarine Tactical Warfare System	0604562N	140	05	Volume 3 - 863
Surface & Shallow Water MCM	0603502N	37	04	Volume 2 - 197
Surface ASW	0603553N	44	04	Volume 2 - 333
Surface ASW Cmbt Sys Integr	0205620N	232	07	Volume 5 - 497
Surface Combatant Cmbt Sys Eng	0604307N	126	05	Volume 3 - 501
Surface Mine Countermeasures	0604127N	87	04	Volume 2 - 1111
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Surface Support	0204228N	221	07	Volume 5 - 209
Tact Air Dir Infrared CM (TADIRCM)	0604272N	88	04	Volume 2 - 1131
Tactical Aim Missiles	0207161N	242	07	Volume 5 - 1027
Tactical Airborne Reconnaissance	0603261N	35	04	Volume 2 - 135
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Tactical Command System - MIP	0304231N	179	05	Volume 3 - 1787
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(U)Science & Tech Management - ONR Field Acts	0602861N	16	02	Volume 1 - 243
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Mine & Exp Warfare Applied Res	0602782N	14	02	Volume 1 - 221
Mine and Expeditionary Warfare Advanced Technology	0603782N	29	03	Volume 1 - 377
Navy Warfighting Exp & Demo	0603758N	28	03	Volume 1 - 369
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Power Proj Applied Research	0602114N	4	02	Volume 1 - 61
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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	117.320	118.130	119.433	-	119.433	117.552	117.498	119.822	122.258	Continuing	Continuing
0000: *University Research Initiatives*	0.000	97.977	118.130	119.433	-	119.433	117.552	117.498	119.822	122.258	Continuing	Continuing
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	101.714	118.130	120.233	-	120.233
Current President's Budget	117.320	118.130	119.433	-	119.433
Total Adjustments	15.606	0.000	-0.800	-	-0.800
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-4.394	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.800	-	-0.800
• Congressional Add Adjustments	20.000	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	19.343	0.000
Congressional Add Subtotals for Project: 9999	19.343	0.000
Congressional Add Totals for all Projects	19.343	0.000

Change Summary Explanation

The funding increase from FY 2018 to FY 2019 reflects additional DURIP, MURI, and PECASE awards.

The FY 2019 funding request was reduced by $0.443 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: N/A

Schedule: N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *University Research Initiatives*	0.000	97.977	118.130	119.433	-	119.433	117.552	117.498	119.822	122.258	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: DEFENSE UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM (DURIP)	33.454	23.022	23.774	0.000	23.774
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.					
FY 2018 Plans: Continue to support university research infrastructure essential to high-quality naval-relevant research.					
FY 2019 Base Plans: Continue to support university research infrastructure essential to high-quality naval-relevant research.					
FY 2019 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 and FY 2019.					
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 Research and Development Framework. 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. ***FY 2018 Plans:*** - Continued to support teams of researchers investigating high priority topics and opportunities thru 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 that intersect more than one traditional technical discipline. ***FY 2019 Base Plans:*** - Continue to support teams of researchers investigating high priority topics and opportunities thru 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 that intersect more than one traditional technical discipline. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 and FY 2019.	60.435	86.438	86.706	0.000	86.706
Title: PRESIDENTIAL EARLY CAREER AWARDS (PECASE)	4.088	8.670	8.953	0.000	8.953

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2018 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 2019 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 and FY 2019.					
Accomplishments/Planned Programs Subtotals	97.977	118.130	119.433	0.000	119.433

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. 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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601103N / *University Research Initiatives*	**Project (Number/Name)** 0000 / *University Research Initiatives*

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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

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 2017	FY 2018
Congressional Add: Program Increase	19.343	0.000
FY 2017 Accomplishments: This increase in Congressional funding furthers the U. S. 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 its technological superiority. Through this increase, additional Multidisciplinary University Research Initiative (MURI) awards, Defense University Research Instrumentation Program (DURIP) awards, and Presidential Early Career Awards for Scientists and Engineers (PECASE) will be selected and funded.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	19.343	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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	18.238	19.438	19.237	-	19.237	19.235	19.225	19.604	20.003	Continuing	Continuing
0000: *In-House Lab Independent Res*	0.000	18.238	19.438	19.237	-	19.237	19.235	19.225	19.604	20.003	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 Research and Development Framework 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 Naval Research and Development Framework 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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	18.508	19.438	19.434	-	19.434
Current President's Budget	18.238	19.438	19.237	-	19.237
Total Adjustments	-0.270	0.000	-0.197	-	-0.197
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.243	0.000			
• SBIR/STTR Transfer	-0.027	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.197	-	-0.197

Change Summary Explanation

The FY 2019 funding request was reduced by $0.140 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *In-House Lab Independent Res*	0.000	18.238	19.438	19.237	-	19.237	19.235	19.225	19.604	20.003	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 Research and Development Framework 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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR) ***FY 2018 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 2019 Base Plans:*** Continue In-house Laboratory Independent Research (ILIR) projects which enables laboratories to sponsor focused, high-risk/potential high reward basic research to the Navy and Marine Corps on a discretionary basis. Each project is funded for at most three years with the goal being to transition successful technologies to either a higher level of research or to a program of record. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 and FY 2019.	15.991	16.873	16.690	0.000	16.690
Title: SCIENCE TECHNOLOGY ENGINEERING AND MATH (STEM) EFFORTS AT NAVY LABS	2.247	2.565	2.547	0.000	2.547

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 Department of the Navy (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. ***FY 2018 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 2019 Base Plans:*** Continue to provide opportunities for approximately 300 high school and 600 college and graduate 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 and FY 2019.					
Accomplishments/Planned Programs Subtotals	18.238	19.438	19.237	0.000	19.237

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	413.826	458.333	458.708	-	458.708	456.885	457.962	466.805	476.133	Continuing	Continuing
0000: *Defense Research Sciences*	0.000	413.826	458.333	458.708	-	458.708	456.885	457.962	466.805	476.133	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 Research and Development Framework. 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 (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: PB 2019 Navy					Date: February 2018
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*		
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	422.748	458.333	469.934	-	469.934
Current President's Budget	413.826	458.333	458.708	-	458.708
Total Adjustments	-8.922	0.000	-11.226	-	-11.226
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-8.891	0.000			
• Program Adjustments	0.000	0.000	-8.031	-	-8.031
• Rate/Misc Adjustments	0.000	0.000	-3.195	-	-3.195
• Congressional General Reductions Adjustments	-0.031	-	-	-	-

Change Summary Explanation

The FY 2019 funding request was reduced by $1.825 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Defense Research Sciences*	0.000	413.826	458.333	458.708	-	458.708	456.885	457.962	466.805	476.133	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: AIR, GROUND AND SEA VEHICLES	51.018	57.160	57.754	0.000	57.754
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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 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;					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2019 Base Plans: Continue all efforts from previous year: 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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; 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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, turbo machinery 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 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.with no new efforts identified. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: ATMOSPHERE AND SPACE SCIENCES	23.862	25.547	25.777	0.000	25.777
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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Accomplishments and plans described below are examples for each effort category. ***FY 2018 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 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** The overall objective of this research is to improve the quality of the atmospheric and space environmental products that are provided to the warfighter and to allow accurate assessment of the impact of space and atmospheric phenomena on the performance of weapon systems. These objectives require advancing our basic understanding of atmospheric and space processes ranging from space to the sea surface, including interactions of the atmosphere with the land, sea, wave, and ice. Intramural Battlespace Environments Navy operations in the littoral zone are affected by complex topography and air-sea-land contrasts and phenomena occurring on very short time and space scales. Clouds and moisture phenomena require further study to improve their representation in models. Non-conventional observational data sources require new and novel data assimilation methodologies to be developed before their potential is fully realized. Systems are being employed which operate in or through the earth's upper troposphere, middle and upper atmosphere and the near space environment where environmental supports are crude or non-existent. The interface between the troposphere and stratosphere is gaining increased attention because of its possible effect upon medium term weather prediction. Extramural Marine Meteorology and Prediction					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research initiatives 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. 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 Space Research Perform best-in-class, experimentally-led sensing research and development (R&D) that is integrated across three environmental areas -- geospace, heliospace, and high-energy space -- which underpin, connect, and inform successful operations, with metrics to increase technology readiness towards rapidly prototyping solutions for accelerated delivery. Geospace research could include Remove key scientific and computational impediments to a future physics-based Navy ionospheric prediction capability recently identified as a critical capability gap for high frequency (HF) radio-wave technologies for electromagnetic maneuver warfare, by means of focused scientific research on identification of which key drivers from the lower atmosphere and thermosphere are necessary to achieve short term forecasts of HF propagation globally. Heliospace efforts may advance our understanding of solar magnetic fields and how they influence the near-earth environment. High-energy space development will assist in understanding particle acceleration mechanisms in high energy solar flares by studying gamma-ray and neutron emissions that are measured in space. Extramural Space Sciences On-going investigation to assimilate 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. ***FY 2019 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: SCIENCE ADDRESSING HYBRID THREATS	16.690	23.696	23.729	0.000	23.729
Description: The Sciences Addressing Hybrid Threats (SAHT) (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 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					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 Plans:*** Sciences Addressing Complex Hybrid Warfare Threats (Formally Known as Counter-Improvised Explosive Device (IED) Sciences) The following Sciences Addressing Complex Hybrid Warfare Threats (SAHT) efforts initiated prior continue in FY18: - 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.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 an effort to integrate observable behaviors with social behavior models to provide inputs for predictions and validation. - Continued research into emerging very-broad-band spectroscopic capabilities to achieve a low-fidelity mosaic of partial pressure detection 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. - Continue 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 an effort to detect a wider variety of homemade explosives. - Continued research into the improved biomechanics and physiology of detection dogs for use in the detection of explosive hazards. - Continued 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.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continued research efforts to explore new lightweight multifunctional material design and techniques to optimize existing materials to improve protection from detonation effects. - Continued research efforts to neutralize or prevent explosive threats with or without direct knowledge of their locations. - Continued research efforts to provide understanding of the human and social elements and their relationships with asymmetric explosive threats to predict and prevent explosive events. - Continued research efforts to improve stimulated electromagnetic explosive signature collection efficiencies. - Continued research efforts to explore compact rapid high selectivity spectroscopic detection in distributed unmanned platforms. 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. 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 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					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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 2019 Base Plans:*** Continue all efforts from previous year, with no new efforts identified. Intramural Electronics					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 Improvise Explosive Device (IED's). 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. Studies on hearing loss from repeated exposure to high levels of acoustic waves created by high performance jet engines operating on ocean platforms. 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. Earlier studies on related topics have provided design and fabrication of protection garments from IED explosives and advanced design concepts for helmets to significantly reduce neuronal damage caused by shock and blast waves. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: HUMAN SYSTEMS	15.755	15.500	16.486	0.000	16.486
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 2018 Plans:*** Human Computer Interaction/Visualization					

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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 2019 Base Plans:*** Continue all efforts from previous year, plus the increased effort within Social Network Analysis. Social Network Analysis					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research on computational social science models for course of action and forecast in support of information environment maneuvers for strategic communication. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 supports increased efforts within Social Network Analysis.					
Title: MATHEMATICS, COMPUTER, & INFORMATION SCIENCES	41.340	45.391	45.870	0.000	45.870
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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 Plans:*** Extramural Communications and Networking 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.					

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

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

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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 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 2019 Base Plans:*** Continue all efforts from previous year, plus the expanded effort identified within Intramural Information Technology.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Intramural Information Technology Specific research examples include security for systems that employ Systems-on-a Chip Integrated Processor architectures, AI systems that understand causal reasoning, robotic systems that take advantage of emerging neuromorphic processors, new algorithms for performing data analytics, and networks that take into account the age of the information on the network for routing decisions. Information Technology: 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 presenting information to users. Specific research examples include security for systems that employ Systems-on-a Chip Integrated Processor architectures, AI systems that understand causal reasoning, robotic systems that take advantage of emerging neuromorphic processors, new algorithms for performing data analytics, and networks that take into account the age of the information on the network for routing decisions. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: MATERIALS/PROCESSES	51.878	56.980	58.270	0.000	58.270
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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 Plans:*** Extramural Structural Materials					

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans: Continue all efforts from previous year, plus the expanded efforts identified within Intramural Undersea Warfare and Intramural Materials and Chemistry Intramural Undersea Warfare Perform laboratory and theoretical/numerical studies focused on creating new techniques for detecting, visualizing, understanding, predicting, exploiting, and controlling the interactions between acoustic and elastic waves such as: underwater coupling architectures that achieve a broad range of acoustic impedances, refractive indices and loss tangents; and the creation of high efficiency silicon based thin film thermoelectric modules for undersea warfare applications by exploiting nanocrystallization, multilayering to control thermal conductivity. (NRL) Intramural Materials and Chemistry Designing advanced materials 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. Some examples of ongoing studies are (1) uncovering					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
the mechanisms in the nanometer scale, (2) understanding the effect of coatings on the conductions of ions and electrons, (3) developing better understanding on the performance of spin-polarized electrons for advanced electronic switches and memories, (4) developing fundamental understanding of electron transfer pathways in microbial consortia and relate the indefinite power generation in benthic regions, (5) 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. Demonstrate materials using 3D printing, mobility of electrons of one spin, design of microbial cells to extract power from the coastal ocean sediments. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase in FY 2019 supports several increased research initiatives in the areas of Intramural Undersea Warfare and Intramural Materials and Chemistry.					
Title: MEDICAL/BIOLOGY	16.936	19.050	19.601	0.000	19.601
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 management; casualty prevention; undersea medicine/hyperbaric physiology; biorobotics; expeditionary operations training; stress physiology and regenerative medicine Accomplishments and plans described below are examples for each effort category. ***FY 2018 Plans:*** Medical Sciences: Undersea Medicine 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					

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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 2019 Base Plans:*** Continue all efforts from previous year, plus the expanded efforts identified within Combat and Operations BioMedicine and Naval Biosciences. Combat and Operations BioMedicine					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research improved hemorrhage resuscitation with enhanced endothelial treatments. Naval Biosciences Research synthetic biology for bioelectronics devices, materials and information processing. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There are no significant change from FY 2018 to FY 2019.					
Title: OCEAN SCIENCES	69.034	75.178	76.135	0.000	76.135
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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 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					

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

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 influence of turbulence generated at the seafloor boundary layer on vertical mixing and stratification in shallow water outside the surf zone.					
FY 2019 Base Plans: Extramural Physical Oceanography and Prediction Continue all efforts from previous year, except for the following. Complete field studies/modeling to predict propagation and effect on acoustics of non-linear internal waves in the western Pacific. Complete studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas. Complete analysis of the structure and variability of the Northern Arabian Sea circulation using autonomous, unmanned sampling systems. Initiate studies of prediction and observations of 3-D Lagrangian studies and abilities to predict the vertical pathways in the ocean. Initiate studies of the input and fate of near-initial shear and energy in the ocean via observational and predictive studies in the GIUK regions. Extramural Littoral Geosciences and Optics Continue all efforts from previous year. Studies emphasize methodologies and/or observing technologies which are cost-effective, rapidly re-locatable, and offer insight into littoral phenomena. Studies to enable use of organic sensors on operational platforms to enhance battlespace situational awareness in continental shelf, nearshore,					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
delta, estuarine, and riverine environments, including such phenomena as surface gravity waves and internal waves, currents, stratification, sediment transport and coastal winds. Understanding very shallow water acoustic propagation in coastal, nearshore, deltaic and riverine environments. Extramural Marine Mammals and Biology Continue all efforts from previous year. Integrated Ecosystem Research - Basic research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Research 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 - Basic research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. 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. Research 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 to better understand the stress response in marine mammals to sound exposure. Research 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. 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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Monitoring and Detection - Basic 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. 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 Continue all efforts from previous year. 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 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					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
only at spot locations by in-situ sampling; and d) quantification of the influence of turbulence generated at the seafloor boundary layer on vertical mixing and stratification in shallow water outside the surf zone. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 supports several increased research initiatives in the areas of Extramural Marine Meteorology and Prediction, Intramural Battlespace Environments, Extramural Space Sciences, and Intramural Space Research.					
Title: SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	44.947	49.752	44.229	0.000	44.229
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. Accomplishments and plans described below are examples for each effort category.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 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 2019 Base Plans: Support 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. Start development of pilot efforts to improve STEM through the development of new curricula and experiential learning activities that respond to new naval Science and Technology personnel and knowledge needs. Expand existing successes to scale working projects and achieve greater impact and implementation of funded efforts. Support new activities to targeting regional efforts to drive greater impact on educational systems and increase workforce opportunity for the naval Science and Technology community. Continue coordination of DON STEM efforts. Enhance and maximize HBCU/MIs faculty and student awareness of STEM and other defense-related educational research opportunities to make significant contributions to Naval Research Enterprise. Support efforts to provide student internships and faculty fellowships that will increase the capability of Science and Technology efforts into a new age of discovery. ONR Global (ONRG) will continue developing the International Outreach Program; even though the decrease in FY 2019 is due to funds being realigned to 0602236N Warfighter Sustainment Applied Research in order to consolidate the ONRG Science Advisors Program.					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The funding decrease in FY 2019 reflects the realignment of funds PE 0602236N Warfighter Sustainment Applied Research in order to consolidate the ONR Global Science Advisors Program.					
Title: SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW)	45.964	49.758	48.386	0.000	48.386
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. Accomplishments and plans described below are examples for each effort category. ***FY 2018 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					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
having improved performance for shallow water Anti-Submarine Warfare (ASW), acoustic and electric signature measurement and control, and energy generation. 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 2019 Base Plans:*** Continue all efforts from previous year, plus the expanded efforts identified within Intramural Undersea Warfare, Intramural Electromagnetic Warfare, and Intramural Materials and Chemistry					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Intramural Electromagnetic Warfare Fundamental research is being conducted looking at revolutionary mechanisms for advanced 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. Other promising avenues of research will allow for asymmetric warfare through image recovery in previously denied conditions, provide the necessary theoretical foundation and produce algorithmic tools for performing target detection and discrimination via multiple resource constrained antennas operating in highly cluttered environments, and significantly improve the ability to track extremely maneuverable targets and handle nonlinear measurements in radar and sonar systems. 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. Improve target identification algorithms utilizing nonlinear dynamics. Understand and demonstrate the principles and mechanisms of DNA-based molecular-scale machines to amplify detection of biochemical agents. Fabricate single atomic layer of materials to create 2-dimensional 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. Understand protein-surface interactions leading highly sensitive biosensors. First principle theoretical models are developed to understand the principles governing the interactions between surfaces and small molecules. Previous studies in these areas have demonstrated success in designing biological and chemical sensors with parts per trillion sensitivity as well as understanding of electronic mobility of graphene due to the effects of edge and defects.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Intramural Undersea Warfare Perform laboratory, field, and theoretical/numerical studies to investigate physical phenomenon related to acoustic propagation and scattering in oceanic environments such as: approaches to predict the scattering signature of a structure using noise sources of opportunity; investigate the fundamental physical phenomena of wave propagation in ocean environments; and approaches to separate of an acoustical field from turbulent flow on an acoustic array. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY 2018 to FY 2019 reflects a reduced investment Intramural Electronics.					
Title: WEAPONS ***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 2018 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	17.885	18.925	20.306	0.000	20.306

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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 2019 Base Plans:*** Research will focus on undersea weaponry; energetic materials and propulsion; expeditionary operations (communications, materials for forensic sensing, landmine detection, human sensory enhancements,					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
lightweight power sources and information efficiency); directed energy, counter directed energy and applied electromagnetics hypersonics. Continue all efforts from previous year, plus the expanded efforts identified within Undersea Weaponry, Directed Energy, Counter Directed Energy, and Hypersonics Undersea Weaponry Pursue advanced concepts for sea warfare and weapons to include conducting basic science and research to explore new ideas and technologies to enhance the performance of existing power & energy sources, undersea weapons, unmanned vehicles, aircraft, ships and submarines for the Navy. Expand autonomous control technology for surface and subsurface vehicles. Directed Energy Explore the scientific limitations of laser technology for utilization at tactically significant ranges. The goals of the program include research of laser sources, adaptive optic compensation techniques, understanding of long range atmospheric propagation physics, and characterization of laser-matter interactions. This program will lead to understanding which DE is best for Naval defense applications. Counter Directed Energy Investigate ability to counter directed energy weapons in high energy lasers or high power radiofrequency devices. Conduct performance assessments of laboratory components in phased experimentation on laser and High Power Microwave protection methods for future naval aviation and surface ship systems and platforms. Hypersonics Basic research will address long-range weapon components able to survive high temperature exposure for several minutes and thwart anti-access/ area denial countermeasures. Additional areas of research include Boundary layer physics in shock-wave dominated flows around highly-swept or slender bodies, Aero-thermo-elastic and/or aero-servo-elastic effects arising from control surface actuation at high speeds, descriptions of high-speed boundary layer transition that unify theories across disparate external conditions, novel strategies for					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
extending regions of laminar flow and advanced hypersonic aerodynamic design tools that incorporate modern predictions of transition pathways, freestream noise contributions, time/heating-dependent surface finish effects, and unsteady aerodynamics. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 suppors several increased research initiatives in the areas of Directed Energy and Hypersonics.					
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 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. Basic Research Challenge award topics are then issued as a broad agency announcement. ***FY 2018 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 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 2019 Base Plans:***	18.517	21.396	22.165	0.000	22.165

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue all efforts from previous year, with no new efforts identified. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increased funding from FY2018 to FY2019 is programmed and necessary to continue the efforts from the previous year which invest in additional areas of new, high-risk basic research projects in multidisciplinary and departmental collaborative efforts. This increase also funds topics that foster leading edge science and attract new principal investigators and organizations. Areas of increased investment include randomized numerical computation for large datasets, levitated optomechanics, multi-principal alloys for high-temperature applications, and multibody control systems for flight dynamics.					
Accomplishments/Planned Programs Subtotals	413.826	458.333	458.708	0.000	458.708

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	69.950	13.553	14.643	-	14.643	14.610	14.651	14.822	15.125	Continuing	Continuing
0000: *Power Proj Applied Research*	0.000	50.607	13.553	14.643	-	14.643	14.610	14.651	14.822	15.125	Continuing	Continuing
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

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 Research and Development Framework. 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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	41.371	13.553	17.736	-	17.736
Current President's Budget	69.950	13.553	14.643	-	14.643
Total Adjustments	28.579	0.000	-3.093	-	-3.093
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	9.796	0.000			
• SBIR/STTR Transfer	-1.090	0.000			
• Program Adjustments	0.000	0.000	-2.936	-	-2.936
• Rate/Misc Adjustments	0.000	0.000	-0.157	-	-0.157
• Congressional General Reductions Adjustments	-0.127	-	-	-	-
• Congressional Add Adjustments	20.000	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	19.343	0.000
Congressional Add Subtotals for Project: 9999	19.343	0.000
Congressional Add Totals for all Projects	19.343	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.113 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Power Proj Applied Research*	0.000	50.607	13.553	14.643	-	14.643	14.610	14.651	14.822	15.125	Continuing	Continuing

Note

Effective FY2018, the Electro Magnetic (EM) Railgun program funding, plans, and associated justification has been realigned to the new innovative naval prototype (INP) PE 0602792N Innovative Naval Prototypes.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: DIRECTED ENERGY	20.752	4.556	6.463	0.000	6.463
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. The decrease from FY 2017 to FY 2018 reflects the realignment of the Solid-State Laser - Technology Maturation (SSL-TM) program funding to the new innovative naval prototype (INP) PE - 0602792N Innovative Naval Prototypes. ***FY 2018 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 Medium					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Wavelength Infrared (MWIR) and Long Wavelength Infrared (LWIR) (4-12 microns), USPL propagations and effects. 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 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. ***FY 2019 Base Plans:*** Directed Energy Research: Continue research and thrusts 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 Medium Wavelength Infrared (MWIR) and the Long Wavelength Infrared (LWIR)-(4-12 microns), USPL propagations and effects. 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: Continue applied research efforts to 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. ***FY 2019 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase in FY 2019 supports increased investment in laser component technologies.					
Title: HIGH SPEED PROPULSION AND ADVANCED WEAPON TECHNOLOGIES	3.813	4.712	3.878	0.000	3.878
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. ***FY 2018 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 2019 Base Plans:*** -Continue current investments to 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 continued 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
research; ultra-high temperature materials research for hypersonic leading edges and nose tips; technology maturation of advanced airframes and controls; high Gforce 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The reduction from FY2018 to FY2019 in this activity is due to a realignment of hypersonics research funds into directed energy research to reflect the increased overall investment in developing speed of light weapons for current threats.					
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 2018 Plans:*** Electronic Warfare: - Continue 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. - Continue 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. - Continue 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). - Continue 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. - Continue development of novel photovoltaic and autonomous soaring technology to enable long range EW sensor delivery systems.	5.755	2.555	2.570	0.000	2.570

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
-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 - Continue 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. - Continue development of methodology to concatenate nanoparticle structures for spectral control of obscurant material - Continue development and prove a method of more efficiently transporting EW sensors using a low Reynolds Number regime boundary layer control system. - Continue development of a water assisted take-off process for electronic warfare sensors. - Continue development of advanced fuel cell technology for UAS to increase on-station time of EW sensors. - Continue 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. - Continue development of ultra-low noise uncooled nanotechnology infrared sensors. - Continue development of nanoatomic sensor nonvolatile memories. - Continue development of electronic field of view and zoom imagers. - 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Electronics -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 2019 Base Plans:*** Electronics: Continue efforts to 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. Electromagnetic Warfare: Continue multiple efforts to address the necessary technologies to engage 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. Recent results in the application of new material concepts applied to IR concepts have received interest by OPNAV for potential follow on consideration pending successful demonstrations. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: STRIKE AND LITTORAL COMBAT TECHNOLOGIES	0.909	1.730	1.732	0.000	1.732
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. ***FY 2018 Plans:*** Conduct applied research in Advanced RF/EO Sensor & Seeker Technologies for Navy and Marine Corp operations and systems. Electromagnetic Warfare: 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Electromagnetic Warfare: Continue 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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: ELECTROMAGNETIC GUNS ***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. Effective FY2018, the Electro Magnetic (EM) Railgun program funding, plans, and associated justification has been realigned to the new innovative naval prototype (INP) PE 0602792N Innovative Naval Prototypes. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***	19.378	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Effective FY2018, the Electro Magnetic (EM) Railgun program funding, plans, and associated justification has been realigned to the new innovative naval prototype (INP) PE 0602792N Innovative Naval Prototypes.					
Accomplishments/Planned Programs Subtotals	50.607	13.553	14.643	0.000	14.643

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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	19.343	0.000
FY 2017 Accomplishments: The rapid advance of commercial unmanned vehicles, the payloads they can transport, and the ease with which they can deliver such payloads to air bases, naval yards and their assets, present a looming, irregular and important threat. Directionally tunable high power microwave weapons provide one direct solution. Research, development and demonstration of this capability are required to rapidly move this unique defensive capability to an operational level.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	19.343	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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	192.579	125.557	124.049	-	124.049	121.889	121.896	124.342	126.868	Continuing	Continuing
0000: *Force Protection Applied Res*	0.000	150.992	125.557	124.049	-	124.049	121.889	121.896	124.342	126.868	Continuing	Continuing
9999: *Congressional Adds*	0.000	41.587	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	41.587

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	158.745	125.557	124.007	-	124.007
Current President's Budget	192.579	125.557	124.049	-	124.049
Total Adjustments	33.834	0.000	0.042	-	0.042
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-4.537	0.000			
• SBIR/STTR Transfer	-4.596	0.000			
• Program Adjustments	0.000	0.000	1.169	-	1.169
• Rate/Misc Adjustments	0.000	0.000	-1.127	-	-1.127

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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*			
• Congressional General Reductions	-0.033	-	-	-	-
Adjustments					
• Congressional Add Adjustments	43.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	14.507	0.000
Congressional Add: *Alternative Energy Research*	19.343	0.000
Congressional Add: *Littoral Threat Research*	4.836	0.000
Congressional Add: *Battery Storage and Safety*	2.901	0.000
Congressional Add Subtotals for Project: 9999	41.587	0.000
Congressional Add Totals for all Projects	41.587	0.000

Change Summary Explanation

The funding decrease from FY 2018 to FY 2019 is due to a phasing down of the applied research effort in the areas of Advanced Energetics Materials and Aircraft Propulsion Technologies.

The FY 2019 funding request was reduced by $0.756 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Force Protection Applied Res*	0.000	150.992	125.557	124.049	-	124.049	121.889	121.896	124.342	126.868	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: AIRCRAFT TECHNOLOGY	64.126	39.461	35.419	0.000	35.419
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 rotor systems, 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. 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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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. ***FY 2018 Plans:*** - Pursue research related to Sea-Based Aviation National Naval Responsibility (SBA 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 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 Unmanned Aerial System (UAS). - Expanding efforts on safe-perception based autonomous control in complex naval environments and on autonomy to support combined unmanned and manned air systems/units. ***FY 2019 Base Plans:*** Ongoing research related to SBA NNR priorities in Aviation, Propulsion, and Structures and Materials. Ongoing research in Aircraft Technology, examples of research/efforts include Virtual Ship/Aircraft Dynamic Interface, Manned/Unmanned Handling Qualities and Control, Automated Deck Operations, High Lift Aerodynamics and V/STOL Operations, the development of rotorcraft/VTOL systems automated launch and recovery technology and mechanical/environmental failure prediction research. Ongoing research in Propulsion, examples of research/efforts include the VCAT Program. Major engine manufacturers and system contractors will develop/mature the highest priority, long-lead propulsion system					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
technologies, including variable/adaptive cycle engine components, for next generation carrier-based TACAIR/ ISR systems. Ongoing research in Structures and Materials, examples of research/efforts include advanced composite durability technology, new materials development, process-property relationship analysis, improved material selection tools, structural life prediction, multi-functional surfaces, and structural optimization for lightweighting.. Expanding material degradation risk prediction and operational environment-driven materials selection methods. Ongoing research related to Autonomy, examples of research/efforts include 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY 2018 to FY 2019 is due to a phasing down of the applied research effort in the areas of Advanced Energetics Materials and Aircraft Propulsion Technologies.					
Title: FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS	2.476	5.754	5.775	0.000	5.775
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. 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. ***FY 2018 Plans:*** Sensors & Associated Processing:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
-Finish Sensors & Associated Processing related efforts to develop an implosion-resistant hydrogen storage technology for use in undersea fuel cells, development of wide area standoff detection of explosives, and study of Electrochemical sensors for the distributed, remote detection of explosives. 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 2019 Base Plans: Undersea Warfare: Ongoing research in Undersea Warfare, examples of research include conceptualizing and performing laboratory and field studies to: developing acoustics technology and associated signal processing for the detection of small unmanned aerial vehicles (UAVs); continued development of a pressure tolerant, inexpensive hydrogen storage based on hydrogenated graphene to increase undersea storage capacity. Materials and Chemistry: Ongoing research in Materials and Chemistry, examples of research include design and development, utilizing room temperature ionic liquids, to demonstrate and fabricate inexpensive, miniaturized, low power					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
electrochemical sensors for use in autonomous as well as distributed sensor networks; developing 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; development and design of a new class of safe high performance rechargeable zinc air batteries to supplant state of lithium-ion batteries; development of chemical vapor sensing strategy for application in a marine environment, significantly different than terrestrial environment; performance demonstrations of highly sensitive electrochemical detection elements incorporated into electronic integrated circuits; and demonstrations of high efficiency of zinc sponge anode in an electrochemical cell. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: ADVANCED ENERGETICS	5.231	5.329	5.497	0.000	5.497
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 2018 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Expand 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 2019 Base Plans:*** Ongoing research related to Advanced Energetics including development and evaluation of advanced explosive/ propellant/reactive ingredients and formulations for the next generation higher performing systems. Ongoing 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. Ongoing research focused on chemical processing technologies. Incorporate molecular design and crystal morphology technology into scale-up and process development. New compliant commodity energetic ingredients will be transitioned to the industrial base as appropriate. Continue 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change form FY 2018 to FY 2019.					
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E) ***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,	74.706	70.382	72.772	0.000	72.772

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
design tools, naval power systems and ensuring a strong and healthy academic infrastructure. Specific research themes are: Advanced Naval Power Systems Technology: 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, distribution and control of power, 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 and 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" Direct Current (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 and 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 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 (USSV) 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 include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
(includes damage control), and advanced naval power systems. Signature reduction addresses electromagnetic, infrared, structural acoustics and acoustic signature tailoring, both topside and underwater. Develop and advance time critical stealth technologies for SSBN and SSN programs. ***FY 2018 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. Finish 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. Advanced Sea Platform 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. Expand research related to the unmanned sea surface vehicle and Medium Displacement Unmanned Surface Vehicle (MDUSV) and USV Swarm 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 and expand efforts related to directed energy weapons, Route Reconnaissance and Clearance methodologies, and development of modular, reconfigurable, integrated multi-modal stand-off detection and neutralization of explosive hazard (IED & Mines) system.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Complete research in the mitigation of Counter Improvised Explosive Devices (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): - Continue base program efforts including network information sciences, long-range high-resolution imaging, ocean surface scatter in radio frequency (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. Continued development of advanced undersea autonomy for Naval missions. Materials and Chemistry: 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 magnesium oxide (MgO) and aluminum oxide (Al2O3). Successful accomplishments have been made to show that graphene can be used as a tunnel barrier material. Electronics: Create and explore new high voltage, high efficiency wide bandgap and ultra-wide bandgap power switches for electric propulsion and electric weapons. ***FY 2019 Base Plans:*** Advanced Energy Systems Research: Ongoing applied research related to critical S&T in Power & Energy Technology related to energy systems. This research in energy systems provides innovative energy technologies and system designs to increase mission capability. Areas of research include all scientific and engineering aspects of the production, conversion, delivery, and use of energy for installation critical infrastructure, forward operating and remote bases, humanitarian assistance and disaster relief operations, manned and unmanned platforms, and general energy network applications. Primary objectives are to improve warfighting readiness, effectiveness, and flexibility through research projects focused on enhancing energy cyber-security, resiliency and efficiency. Research programs often include activities that purposely incorporate veterans and other military personnel into projects					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
to enhance military applicability and to provide a sustainable source of military-experienced professionals for the DoN energy workforce. Advanced Naval Power Systems Technology: Ongoing research related to the 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. Advanced Sea Platform Technology: Ongoing applied research related to critical S&T to investigate platform design efforts related to propulsor and subsurface hydrodynamics; structural reliability science; and structural acoustics. Expand research related to the unmanned sea surface vehicle. Ongoing research related to naval engineering and platform design, including Ohio Replacement Program efforts. Sea Platform Survivability Technology: Ongoing 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 Warfare Threats: Ongoing 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. The S&T technologies will continue to expand and emphasize various compact platforms in multi-environments. Applied Research Challenge (ARC): Ongoing base program efforts, initiated in FY 2017 and FY 2018, 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. In particular, continue research to develop and test autonomy for Unmanned Undersea Vehicle (UUV) missions including understanding of counter-UUV autonomy options; implementations and testing.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Materials and Chemistry: Ongoing research for understanding methods for fabricating nickel/graphene/cobalt magnetic tunneling junctions to develop new tunnel barrier materials technology for fast low power radiation hardened memory and magnetic sensors. This continuing effort will be a fundamental shift for magnetic tunnel junction technology, which is significantly different than the use of conventional oxides such as MgO and Al2O3. Favorable accomplishments have been made to show that graphene can be used as a tunnel barrier material. Electronics: Ongoing research to create and explore new high voltage, high efficiency wide bandgap and ultra-wide bandgap power switches for electric propulsion and electric weapons. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 reflects an increase in the Advanced Energy Systems Research area.					
Title: NAVAL RESEARCH ENTERPRISE	4.453	4.631	4.586	0.000	4.586
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 Naval Research and Development Framework 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2018 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 2019 Base Plans:*** Independent Applied Research (IAR) shall align with the CNR's framework priorities (IAR projects which were three years in duration); Augmented Warfighter, Integrated & Distributed Forces; Operational Endurance, Sensing and Sense-Making, and Scalable Lethality. FY19 IAR projects will expand efforts in the areas of physics, chemistry, biotechnology, earth sciences, mathematics, and other hard and soft sciences. Representative projects include; Life Preserver Performance in Waves, Electronic Warfare Activity Recognition, Boron-Based Solid Fuel Development for Ramjet Application, Modularization Algorithm for Additive Manufactured Parts, Data Visualization Support for Creation of a Numerical Table: Effects on Training and Performance, Development of a Fully Integrated Ignition System for Multiple Pulse Hybrid Rocket Motor Firings, Active Sonar-based Cooperative UUV Interception, HFA Tactical Oceanography, and Ultra Short Pulse Laser Induced Plasma Filaments for Extended Covert Communications. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	150.992	125.557	124.049	0.000	124.049

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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 Navy energy guidance and efforts in support of the Ohio Replacement program.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	0.000	41.587	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	41.587

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase ***FY 2017 Accomplishments:*** Funding used to advance research and facilitate technology adoption for lithium-ion battery safety and electrical grid resiliency, reliability and security. ***FY 2018 Plans:*** N/A	14.507	0.000
Congressional Add: Alternative Energy Research ***FY 2017 Accomplishments:*** Funding used to continue to carryout alternative energy research in several areas including modeling and simulation tools for energy efficient ship design, unmanned vehicle power systems, cyber-secure and resilient micro-grids, marine-derived renewable energy, and a variety of shore-based energy efforts addressing energy challenges in the Asia-Pacific regions, including Hawaii, Guam, California, and Australia. ***FY 2018 Plans:*** N/A	19.343	0.000
Congressional Add: Littoral Threat Research ***FY 2017 Accomplishments:*** Conducted studies to characterize littoral battlespace environments including continental shelf, slope and deepsea environments having complex bathymetry and geophysical properties. ***FY 2018 Plans:*** N/A	4.836	0.000
Congressional Add: Battery Storage and Safety ***FY 2017 Accomplishments:*** Funding used to continue the development of safer battery technologies, including non-flammable electrolytes and safe cell technology. This funding continued and expanded the on-going competitively awarded efforts that improve Li-ion battery safety. ***FY 2018 Plans:*** N/A	2.901	0.000
Congressional Adds Subtotals	41.587	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 9999 / *Congressional Adds*

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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	67.874	53.936	59.607	-	59.607	56.604	50.623	51.624	52.674	Continuing	Continuing
3001: *Marine Corps Landing Force Tech*	0.000	48.531	53.936	59.607	-	59.607	56.604	50.623	51.624	52.674	Continuing	Continuing
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

A. Mission Description and Budget Item Justification

This PE addresses demand signals emphasized by the Commandant of the Marine Corps, the Chief of Naval Operations, and the Chief of Naval Research, as well as those pulled from dynamic engagement with stakeholders. Research efforts are carefully selected to ensure they have the potential to expand warfighting capabilities, inform operational concepts and requirements development, and advance state of the art technology and scientific knowledge. Current guidance also highlights the need to accelerate our pace of development and guide the approach to rapid experimentation, prototyping, and learning.

As reflected in the Marine Corps Operating Concept, the current strategic guidance from the Commandant, expeditionary forces will conduct maneuver warfare in environments characterized by complex terrain, technology proliferation, information used as a weapon, a battle of signatures, and an increasingly contested maritime domain. Additionally, an emergent operation stressor is the contested urban environment which exemplifies the characterizations listed above. The urban environment is one of the most complex terrains with physical compartmentalization and canalization, additional physical dimensions (subterranean and multi-story structures), crowded conditions and associated threat obscuration, communications challenges, informational and human aspects, and proliferation of observation and fires technologies. This environment requires capabilities addressing all the activities within this PE and while it provides many challenges, unique opportunities are also presented and can further shape technology approaches.

These future challenges and portents demand robust technologies for the Marine Corps, but the technology options are constrained. They must have a lightweight deployable character, and the ability to operate in austere conditions with little fixed infrastructure or support while retaining the agility and lethality of an integrated maneuver force. Technology must provide full spectrum capability against robust and complex peer and near-peer adversaries while meeting size, weight, power, cost (SWAP-C) limitations, and information availability within distributed, intermittent and limited (DIL) environments.

The approach within this PE encompasses ideas that support both revolutionary and evolutionary capabilities, and in this way considers and balances both "push" and "pull" aspects of technology projects. 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: PB 2019 Navy	Date: February 2018
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*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	51.590	53.936	60.036	-	60.036
Current President's Budget	67.874	53.936	59.607	-	59.607
Total Adjustments	16.284	0.000	-0.429	-	-0.429
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.880	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.429	-	-0.429
• Congressional General Reductions Adjustments	-0.011	-	-	-	-
• Congressional Directed Reductions Adjustments	-1.825	-	-	-	-
• Congressional Add Adjustments	20.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	19.343	0.000
Congressional Add Subtotals for Project: 9999	19.343	0.000
Congressional Add Totals for all Projects	19.343	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.251 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not Applicable.

Schedule: Not Applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
3001: *Marine Corps Landing Force Tech*	0.000	48.531	53.936	59.607	-	59.607	56.604	50.623	51.624	52.674	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds applied research; technology assessment, road mapping, and concept development; and less technologically mature projects within the Future Naval Capability (FNC) process as means to inform, enhance, enable, and invent future concepts and capabilities with new S&T. This project is organized into ten activities, the core of which is represented by the eight Expeditionary Warfighting Capability Areas.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4)	4.613	4.419	4.430	0.000	4.430
Description: This activity investigates robust, resilient, and secure networked communications pathways and capability that support an expeditionary force's distributed and disaggregated operations. Research supports both networked and local computation for communications that exploits the expeditionary forces close physical proximity to threats while mitigating shortfalls commiserate within DIL environments. Expeditionary forces must operate in the cyber domain and in addition to defending communications networks, vehicles, and weapons systems, are reliant on electronic controllers for basic operations and as such are susceptible to cyber attacks. Technologies addressed within this activity include secure, robust, self-forming, mobile communications networks; distributed computing to support information dissemination to all echelons; improved capabilities in over-the-horizon, beyond line-of-sight, and restricted environment communications and sensors; and software and data processing to support formation of an appropriate common picture. Other efforts include power management, low detectability, conforming to SWAP-C constraints, and interoperability within the joint environment. ***FY 2018 Plans:*** - Continue development of urban/restricted environment communications technologies. - Continue Adaptable Antennas, Self-Adapting Radio Prototype and RF Technologies efforts. - Complete a limited distributed, Cyber Technology development effort. - Complete a meta-material antennas effort. - Complete an Electro-Magnetic Technologies effort. - Complete Cognitive Networking and Trusted Computing Technology efforts. - Initiate Advanced Expeditionary Cyber Technology efforts.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Initiate Photonic Component Technologies - Initiate Full Duplex Technologies - Transfer all USMC applied research Cyber Technology to Expeditionary Cyber Activity. ***FY 2019 Base Plans:*** Understanding the lightweight, deployable character of expeditionary forces, efforts are focusing on the improving and expanding the operational capability of C4 which requires rethinking many of the underlying technologies. Investigations include increasing bandwidth and dynamic range in portable systems. Also included are electromagnetic signature management, countermeasure and interoperability technologies to manage control and exploitation of the electromagnetic spectrum. Focus is also on developing underlying technologies to enable multifunction operations at multiple-domain cryptography and security levels. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: FIREPOWER	6.388	6.131	8.190	0.000	8.190
Description: The activity investigates a large variety of weapons to provide the warfighter with a decisive, yet surgical, tactical advantage to collectively address 21st-century combined-arms warfare against peer and near-peer states. Research efforts increase the reach, lethality and capacity, while retaining mobility and tempo beneficial to expeditionary maneuver warfare. Maintaining focus on size, weight, power, cost (SWAP-C) and distributed, intermittent and limited (DIL) environments stresses the technical solutions available. Technologies being developed are intended for application on both current and future expeditionary weapons and elements of the kill chain. They include, but are not limited to, the following: fuze, fire control, launch/ propulsion, lethality, and accuracy. ***FY 2018 Plans:*** - Continue 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. - Continue development of precision fires engagement technologies, to include trajectory shaped 81mm mortars, 83mm missiles, and smaller precision munitions.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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, during all conditions (daylight, limited visibility, & darkness), by integrating multiple optics capabilities into a single system. - Continue Semi-Autonomous Fires Technology. - Continue Awareness for Lightweight Engagements and Remote Targeting (ALERT) to develop large - 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. - Complete development of concepts for a 155mm mortar or self-propelled Howitzer that would utilize existing stockpiles of 155mm artillery ammunition. - Complete Caseless, Lightweight, Low-volume Round (CLLVR) to develop lightweight, small caliber ammunition for individual, crew served, and remotely mounted weapons. - Initiate High-Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) to develop high-reliability sub-munitions fuzing technologies. - 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 2019 Base Plans: This activity will continue research of end-to-end navigation technologies suitable for flight corrections of gun launched munitions in satellite and network denied environments. Development of real-time, multi-spectral target detection and identification systems continue for individual shooters, providing anomaly and object detection and decision-aid algorithms. Materials research focuses on thin film coatings that change how munitions interact with electromagnetic waves, and on novel materials and processes to improve energetic output of explosives. Munitions efforts will focus on increasing range and precision at low cost.					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
This funding increase from FY 2018 to FY 2019 supports the acceleration efforts to improve cannon-fired submunitions reliability.					
Title: FORCE PROTECTION	5.939	6.679	6.670	0.000	6.670
Description: This activity investigates new ways and means to protect forces and materiel across all operational settings, from contested sea-land surface interfaces to complex urban environments. The portfolio protects against adversaries' challenges such as guided-rockets and missiles, mobile coastal artillery, threat EW, and counter-ISR. Mines and obstacles both in the water and ashore also complicate amphibious landings. The activity invests in vehicle survivability aspects that are exacerbated due to SWAP-C constraints inherent to Marine Corps operation and the harsh nature of the amphibious environment. Technologies addressed include lightweight armor for ballistic and underbody blast protection, advanced sensors for counter tactical surveillance, active protection, and signature management. This activity also considers technology for payloads, packages and sensors that are needed by amphibious vehicles (both manned and unmanned) including mine counter measures; explosive hazard defeat systems; and obstacle and threat detection systems as well as technologies for improved protection for individuals against blast, ballistic and blunt impact threats. ***FY 2018 Plans:*** - Continue development of technologies for stand-off detection and neutralization of mines, IEDs, and Unexploded Ordnance (UXO). - Continue development of technologies to defeat side/top attack and advanced mine fuzes (seismic, acoustic, and infrared) through advanced signature reduction, duplication, and projection. - Continue a program to determine the feasibility to detect and neutralize anti-helicopter mine threat. - Continue broad based material (ceramics, fiber and fiber re-enforced plastics) studies so that significant weight reductions (greater than 50%) can be achieved. - Continue 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. - Continue 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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. - 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). - 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. - 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. -Initiate projects that enable detection of explosive hazards and surveillance/targeting systems in challenging operational environments based on previous study.					
FY 2019 Base Plans: This activity is emphasizing developing miniaturized hardware sensing systems for the detection of threats across a variety of sensing modalities to include visual, thermal, RADAR, and LIDAR to take advantage of unique susceptibilities of threat systems at significant ranges. Leveraging these sensor systems, there will be development of computer vision and machine learning approaches for automated target recognition within these innovative sensing modalities. Work also continues to track technologies in the area of passive armor but there will be decreasing investments in this area until basic research in materials science provide opportunities for significant improvement in protection levels.					
FY 2019 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: HUMAN PERFORMANCE, TRAINING AND EDUCATION	4.798	3.153	3.687	0.000	3.687
Description: This activity investigates two technology investment areas, warrior resilience, and decision-making and expertise development. Warrior resilience is focused on advanced training technologies and methodologies that enhance neural, cognitive, and physical readiness. Decision making and expertise development accelerates the development and improves the retention of skills in decision making, situation awareness, and individual and team adaptability and coordination on decentralized, dynamic and dispersed battlefields. ***FY 2018 Plans:*** - Continue studies into next generation physical performance enhancement methodologies and technologies (enhanced warfighter psycho-physical performance). - Continue research to evaluate the feasibility of integrating augmented reality technologies into current and emerging training systems. - 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. - 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 automated simulation content generation via a field worn sensor suite. - Initiate research for establishing optimal training intervals for improvement in physical performance and warrior mindset. - Initiate the use of augmented reality technologies into tactical decision making tools to support information dominance requirements.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Initiate research into developing artificial intelligence to support infantry simulation based training. ***FY 2019 Base Plans:*** As efforts decrease in the areas of trauma mitigation and functional movement studies, focus will shift towards simulation-based training, operational decision tools, and physical training tools. Rapid advances in artificial intelligence and terrain and environment collection have provided an opportunity to explore potential impacts into tactical unit-level infantry training and mission planning. Efforts will investigate means with which to document, classify, and data collect on current training programs enabling the development of tools to enhance these programs to increase effectiveness and minimize injury. Efforts will also include an increase in training tools for operation in Electronic Warfare (EW) and Cyber contested environments. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 reflects increased investment in research associated with training tools for operation in EW and Cyber contested environments.					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) ***Description:*** This activity investigates enhanced 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 biometric monitoring for expeditionary operations, operational course of action (COA) development, and autonomous surveillance in support of distributed operations. ***FY 2018 Plans:*** - Continue 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. - Continue research to develop algorithms that can disambiguate complex network graphs containing millions of sparsely characterized nodes. - Continue research in deep machine understanding of information requirements relevant to amphibious warfare. - Continue research on technologies needed to enable multi-INT sensors to collaborate in real time on complex fusion tasks.	3.082	6.953	6.969	0.000	6.969

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue a project to enable the synchronized planning and management and ISR assets given a set of disparate mission information requirements. - Continue effort to represent disparate data as a reduced feature vector. - Continue research in analytics for limited and isolated computational environments to enable advanced analytic capabilities to be available on expeditionary lightweight computing platforms. - 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. - Complete development of distributed information architecture technologies. - 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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. - 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 2019 Base Plans: This activity will begin to divest investments in hardware centered approaches to low power sensing and advanced optical components for multi-spectral imagers. However, investments in smart graphs, network shaping metrics, actionable visualizations will continue. Increased focus will be on investments in context aware (smart) artificial intelligence, automation, machine learning, deep learning, and computer vision algorithms. Additionally work will begin on research in strong artificial intelligence applied to the domain of decision support					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
(memory neural networks) and in context adaptive pattern recognition systems (looping), as well as to leverage foundational theory for reinforced learning ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: USMC FNC TECHNOLOGY CANDIDATES	8.777	4.730	4.799	0.000	4.799
Description: This R-2 Activity, formerly named USMC Future Naval Capabilities (FNCs), addresses the applied research associated with the Marine Corps' participation in the Department of the Navy's (DoN) Future Naval Capabilities (FNC) Program. The objective of the work in this PE is to develop and mature technologies needed by the Marine Corps to initiate FNCs in PE 0603640M Marine Corps Advanced Technology Development (ATD) that can be commenced at higher Technology Readiness Levels (TRLs). Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0602750N Future Naval Capabilities Applied Research, where the Navy's participation in the FNC Program is funded. The FNC Program was restructured for FY19 to accelerate transition to the Fleet and Force. This restructuring involved a zero based review of all ongoing FNC projects where each effort was assessed for its technology maturity and transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some efforts were terminated and others were accelerated to achieve the goals of the restructured program. FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, are being resourced in PE 0603640M Marine Corps Advanced Technology Development (ATD). Funding for technology candidates at lower TRLs (3 to 4) is being resourced in this PE. ONR is working closely with the Resource Sponsors and acquisition stakeholders to develop high priority technological capabilities needed by the operational forces. Prior to FY19, the underlying FNC Program investments in this PE were aligned to specific FNC projects. In order to increase agility, exploit technology advances, and respond quickly to naval needs, future applied research investments supporting FNC technology candidates are being developed in a more flexible manner. This approach facilitates an optimum response when developing and maturing the technology options that will be developed further in PE 0603640M Marine Corps Advanced Technology Development (ATD). The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. Investments are organized to enhance collaboration with the acquisition stakeholders and their resource sponsors. A complete accounting					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
of the technologies being developed and a full disposition of each technology development effort referenced as continuing in the FY18 plans of this PE will be provided separately to the Congressional oversight committees. ***FY 2018 Plans:*** - Continue Automated Processing for Spectral Exploitation and Dissemination (APSED) - Develop autonomous cueing algorithms. - Continue 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. - Continue Radar / Context Fusion - Research and design software algorithms to summarize Human Intelligence (HUMINT) data as a spatial threat surface. - Continue Data Conditioning - Research and design machine content extraction algorithms and algorithms capable of formatting a structured report. - Continue 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. - 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. - Complete EMW-FY16-01 Densified Propellant Fire From Enclosure - Confined Space(FFE/CS) Propulsion Technologies. - 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 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that focus on developing and maturing new capabilities for asymmetric and irregular warfare, distributed operations, information dominance, maneuverability, survivability, self-defense and expeditionary warfare. ***FY 2019 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: LOGISTICS ***Description:*** This activity investigates the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. 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. This includes efficient and responsive force sustainment, planning and directing logistics operations, logistics demand reduction, fleet maintenance, and expeditionary energy. Expeditionary Energy enhances combat capability of expeditionary warfighters by increasing the efficiency and effectiveness of energy production, storage, distribution and use. Beyond traditional energy efforts, this portfolio also looks at other issues, including energy-efficient behaviors and hybridization of energy sources. These pillars are thoroughly integrated and perpetually related in execution. ***FY 2018 Plans:*** - Continue applied research toward materials that will reduce, or prevent, wear and corrosion on systems and equipment. - Continue development of high efficiency, high specific power, rugged, and inexpensive solar photovoltaic energy harvesting technologies. - 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.	5.688	5.789	5.784	0.000	5.784

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. - Complete the development of stochastic studies to model and insert Additive Manufacturing into the Naval Supply Chain. - Complete the development of a project to investigate the feasibility and attributes of the wireless transfer of power technologies for dismounted Marines. - 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 2019 Base Plans: This activity includes research area developing technologies to anticipate and reduce maintenance demands while increasing reliability. This includes applied research and evaluation of advanced manufacturing methods including metal additive manufacturing (AM), friction stir welding and additive friction stir welding, and cold spray for structural repair of Marine Corps equipment. Additional focus will be on developing a thorough understanding of material Process-Structure-Properties-Performance for high hard steel repair and other structural materials. This research area also includes applied research to predict vehicle health and prognostics of remaining useful life for military ground vehicles and equipment in support of Condition Based Maintenance goals, while seeking to automate CBM practices through automatic data retrieval and algorithm development. The focus of this investment area includes enhancing combat capability by increasing energy production, storage, distribution, and curbing energy consumption of the individual Marine and other tactical assets. Activities involve applied research into new, rugged, low cost, and high specific power solar cell technologies that are compatible with military use on flexible substrates, while overcoming current limitations including short-lived cell stability and small area cell growth. Additionally, investigations will take place for developing more energy efficient components for the Marine warfighter and high energy and power density					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
technologies to simultaneously curb exponential power use trends, reduce combat load, and enhance mission duration and combat performance. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: MANEUVER ***Description:*** This activity investigates new ways and means to land forces and material through contested sea-land surface interfaces and then conduct maneuver warfare. In order to enable future Amphibious Operations, research efforts will support autonomous operations across the sea-surf-ground environment, improved fuel efficiency and speed of amphibious vehicles, amphibious vehicle technologies, water performance, and amphibious payloads to change the dynamics of a surface amphibious assault. This includes the emergence manned-unmanned teaming and autonomous vehicle collaboration. The technologies included in this work address areas of mobility, materials, propulsion, signature reduction, modularity, and unmanned systems. ***FY 2018 Plans:*** -Continue lightweight Expeditionary Systems Materials (ESM) efforts to determine feasibility of scaling and producing candidate structural armor. - Continue mobility enhancement development effort for current and future light and medium weight Marine Corps vehicle programs. - Continue efforts addressing technologies to mitigate acceleration and traumatic brain injuries to vehicle occupants. - Continue 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. - Continue efforts addressing improvements in vehicle fuel efficiency by improvements in drive train efficiencies, engine efficiencies and alternative fuels capabilities to enhance tactical mobility.	7.753	7.837	10.516	0.000	10.516

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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. - Continue 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). - Continue the development of autonomy technologies and system concepts that will enable unmanned ground vehicles (UGVs) to be used as autonomous logistic connector vehicles. - Continue lightweight armor, material, and structural technologies that enable maneuver and survivability of small, light expeditionary platforms. - Continue 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. - Continue non-GPS localization technologies such that autonomous vehicles can navigate in areas where satellite data is inaccessible. - Continue the development of technologies that enable vehicle component modularity and reduce life cycle costs. - Continue mobility technologies that enable improved vehicle agility and stability. - Continue 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. - Continue the development of technologies that sustain vehicle components longer and reduce life cycle costs. - Continue the development of autonomous technologies automating behavior generation and enabling adaptive behavior using virtual environments. - Continue technology development programs to address expeditionary maneuver capability gaps. - Continue the development of fuel saving vehicle technologies, including advanced transmission, power train, and electrical power system technologies. - Continue the development of autonomous technologies by enhanced human machine interface (HMI) through gestures and natural language understood by unmanned ground systems (UGS). - Continue survivability technologies to provide reduction in the probability of detection in a given background. - 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 technology development programs to address expeditionary High Water Speed capability gaps.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Initiate development of cognitive reasoning systems that enable manned-unmanned teaming with high levels of autonomy. ***FY 2019 Base Plans:*** Efforts will research advanced mobility technologies and concepts for tactical and combat ground and amphibious vehicles to extend the operational reach and range, enable higher operational tempo over rough terrain, and to provide protection against cyber threats. This activity will emphasize efforts on providing an autonomous capability to the amphibious fleet for maneuver from ship to shore in a contested landing environment. Also planned for development is autonomous perception, path planning, and vehicle controls for amphibious vehicles from small low cost craft, traditional amphibious combat and assault vehicles, and landing craft. Research will develop knowledge and models for characterizing the surf zone impacts on amphibious craft to allow for physics based simulation of unmanned amphibious craft transition from sea to land environments. Also to be explored are vision based perception systems capable of robust object recognition and complex scene understanding in dynamic environments. In addition efforts will address technologies that can lead to next generation manned ground vehicles. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase form FY 2018 to FY 2019 supports accelerated development of novel approaches to swarming small, low cost autonomous amphibians across open water, surf zone, and land environments.					
Title: EXPEDITIONARY CYBER ***Description:*** This activity provides 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, limited 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.	0.000	6.790	6.969	0.000	6.969

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Effective 2018 all USMC applied research Cyber Technology was transferred from C4 to Expeditionary Cyber ***FY 2018 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 2019 Base Plans:*** Cyber related encryption and multiple-domain processing tools are developed to enable a new class of portable devices that can securely transfer information across multiple tactical user platforms. Research is performed on the phenomenology of cyber battle damage on a class of systems, and results are used to develop hardware and algorithms for assessing cyber system health. Develop and test a new class of component technologies, architectures, and embedded algorithms that demonstrate improved cyber-EW resilience. Technologies are developed to perform autonomic monitoring and self-healing of EW-cyber, C4, and information exchange systems. Cyber behavior research will also be performed on a class of autonomous systems to demonstrate optimized stability, efficiency and resiliency. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: FUTURE CONCEPTS, TECHNOLOGY ASSESSMENT, AND ROADMAPPING	1.493	1.455	1.593	0.000	1.593
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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 Plans:*** - Continue planning and integration of technology development efforts to meet imposing security threats that challenge our Nation. - Continue 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. - Continue a technology assessment for a Cyber/Electronic Warfare Coordination Cell (CEWCC) to enable seamless integration of kinetic and non-kinetic fires during expeditionary operations. - 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. - Continue planning and integration of technology development efforts to meet imposing security threats that challenge our Nation. - Continue 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. - Continue a technology assessment for a Cyber/Electronic Warfare Coordination Cell (CEWCC) to enable seamless integration of kinetic and non-kinetic fires during expeditionary operations. - 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 2019 Base Plans:*** Assess technologies that best address warfare environments and drivers described in the Marine Corps Operating Concept (MOC) and the Navy's A Design for Maintaining Maritime Superiority. This includes technologies within expeditionary design constraints that exploit scientific opportunities, and develop technology concepts to enable the execution of maneuver warfare in environments characterized by complex terrain including dense urban, technology proliferation, information used as a weapon, battles of signatures, and an increasingly contested maritime domain. Focus on and assess strategies that develop and field more flexible and					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
adaptive technology quicker and with unit costs that win battlefield economics. Create roadmaps and concepts that enhance expeditionary capabilities against peer and near-peer adversaries whose technologies rival our own. Explore science and technology approaches that can speed up assessment, exploitation, and delivery of capability to expeditionary warfighters. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	48.531	53.936	59.607	0.000	59.607

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 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: PB 2019 Navy			Date: February 2018
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COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	19.343	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.343

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	19.343	0.000
FY 2017 Accomplishments: FY17 Interdisciplinary Cybersecurity Research: Building on the multi-disciplinary science and technology strategy from prior year work, this effort will analyze threat intelligence information and design a targeted research program best able to counter the expeditionary cyber domain challenge at the tactical edge. This tactical cyber research program will address the cross-functional fields of cyber security, cyber engineering, and cyber-human interactions. The architectures, technologies, and approaches developed will include dynamic cyber defense techniques to limit the adversary's cyber reconnaissance, methods of visualizing the cyber/electromagnetic environment, and decision tools to assist the Marines in defending, and utilizing to full capability, their tactical networks and systems. Once completed and matured, these will provide future situational awareness and cyber defense capabilities for Marine Corps tactical vehicles, sensor systems, autonomous systems, and more. FY17 Marine Corps Asset Life Cycle Management: This effort will conduct research and development into capabilities that deliver information and insights into vehicle condition and it's relation to preventative maintenance or repair. These insights will include both the detailed information on vehicles systems as well as the resultant condition due to operations and activities. Other investigations will include new methods of efficient and effective resupply or remanufacture of vehicles parts.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	19.343	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	40.649	36.450	36.348	-	36.348	36.486	36.616	37.340	38.099	Continuing	Continuing
0000: *Common Picture Applied Research*	0.000	40.649	36.450	36.348	-	36.348	36.486	36.616	37.340	38.099	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 Research and Development Framework. 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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	41.185	36.450	38.376	-	38.376
Current President's Budget	40.649	36.450	36.348	-	36.348
Total Adjustments	-0.536	0.000	-2.028	-	-2.028
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.001	0.000			
• SBIR/STTR Transfer	-0.528	0.000			
• Program Adjustments	0.000	0.000	-1.690	-	-1.690
• Rate/Misc Adjustments	0.000	0.000	-0.338	-	-0.338

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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*			
• Congressional General Reductions Adjustments	-0.009	-	-	-	-

Change Summary Explanation

The FY 2019 funding request was reduced by $0.229 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Common Picture Applied Research*	0.000	40.649	36.450	36.348	-	36.348	36.486	36.616	37.340	38.099	Continuing	Continuing

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: COMMUNICATION AND NETWORKS	7.195	7.283	7.242	0.000	7.242
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: 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Information Technology: Objective is to provide resilient and effective 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. Current work and near-term plans 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. Specific research examples include increasing the performance of low powered networks by using compressed sensing technology and technology to improve the design of distributed and cooperative Intelligence, Surveillance and Reconnaissance (ISR), Integrated Cyber and Electronic Warfare (ICE) operations in denied and contested Electromagnetic environments. Continue ongoing research and related thrusts 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: APPLIED INFORMATION SCIENCES FOR DECISION MAKING	24.688	22.519	22.434	0.000	22.434
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. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. 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 2019 Base Plans:*** Information Technology: Objective is to improve the operational capability and security 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. Specific research examples include technology to detect and remediate security vulnerability in Commercial-off-the-Shelf software, technology to identify and locate individuals of interest using					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
multi-biometrics, technology for goal driven autonomous systems, and technology to improve performance of Navy Watchstand personnel who must monitor multiple workstations concurrently. Electromagnetic Warfare: The technologies being developed are 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 combined with other information sources. This is being accomplished by expanding specific emitter identification technologies into areas detecting previously unaddressed and unexplored to maintain 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: 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. The amount of data that the decision makers are facing today is much larger than any time before in human history. In addition, the data is much more complex, heterogeneous and fast changing. Analysis of such large and complex datasets is beyond the cognitive abilities of any single decision maker. The aim of this thrust is to develop new methods					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
for extraction and analysis of relevant information from large-scale datasets, and to develop new tools for distributed information sharing and decision-making. To achieve this aim, it is required to advance fundamental understanding of networks (such as social and organizational networks), and to integrate rigorous methods from mathematical and computational sciences with methods from social sciences. 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. 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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.	2.863	1.530	1.535	0.000	1.535

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2018 Plans:*** Electromagnetic Warfare 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 2019 Base Plans:*** Electromagnetic Warfare: 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 High Frequency (HF) surface wave radar array geometries should greatly improve operational capabilities in this reinvigorated part of the Radio Frequency (RF) spectrum. A new concept for rapidly assessing concurrent multiple missiles with multiple Electronic Warfare (EW) responses is being investigated to provide for rapid high quality assessment in this complex environment. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: TACTICAL SPACE EXPLOITATION ***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.	5.903	5.118	5.137	0.000	5.137

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2018 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 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 2019 Base Plans:*** Tactical Space Exploitation: Space Research and Spacecraft Technology: Continue development of advanced, high-payoff technologies that will preserve, protect, and enhance space capabilities in the performance of functions that are of critical importance to Navy-Marine Corps operations while also reducing the cost of DoD space activities. Next-Generation Sensing example: Conduct effort to develop a single pixel camera architecture for passive microwave imaging, maintaining currently delivered spatial resolution and calibration performance while significantly reducing current aperture diameter. Spacecraft Technology example: Initiate development of a new capability for local space situational awareness (SSA) with a novel system that detects and tracks objects in close proximity to a satellite that is equipped with this capability. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	40.649	36.450	36.348	0.000	36.348

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE supports the development of technologies that enable Information Warfare including 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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	50.465	48.649	56.197	-	56.197	56.133	55.869	57.065	58.387	Continuing	Continuing
0000: *Warfighter Sustainment Applied Res*	0.000	45.629	48.649	56.197	-	56.197	56.133	55.869	57.065	58.387	Continuing	Continuing
9999: *Congressional Adds*	0.000	4.836	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.836

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 Research and Development Framework 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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	45.467	48.649	48.448	-	48.448
Current President's Budget	50.465	48.649	56.197	-	56.197
Total Adjustments	4.998	0.000	7.749	-	7.749
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.958	0.000			
• SBIR/STTR Transfer	-0.952	0.000			
• Program Adjustments	0.000	0.000	8.376	-	8.376
• Rate/Misc Adjustments	0.000	0.000	-0.627	-	-0.627
• Congressional General Reductions Adjustments	-0.008	-	-	-	-
• Congressional Add Adjustments	5.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	4.836	0.000
Congressional Add Subtotals for Project: 9999	4.836	0.000
Congressional Add Totals for all Projects	4.836	0.000

Change Summary Explanation

The funding increase from FY 2018 to FY 2019 is due to the realignment of funds from PE 0601153N Defense Research Sciences to 0602236N Warfighter Sustainment Applied Research to consolidate ONR Global - International Science Program support costs.

The FY 2019 funding request was reduced by $0.459 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Warfighter Sustainment Applied Res*	0.000	45.629	48.649	56.197	-	56.197	56.133	55.869	57.065	58.387	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: ADVANCED NAVAL MATERIALS	8.389	11.018	11.455	0.000	11.455
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.					
FY 2018 Plans: ADVANCED NAVAL MATERIALS: 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. MATERIALS AND PROCESSES: 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Compositional modifications and processing parameters to optimize material performance have been demonstrated. ***FY 2019 Base Plans:*** ADVANCED NAVAL MATERIALS: Continue research on structural materials, including, but not limited to, the following: Nanostructured materials processing, composite development, cellular materials, high temperature materials and alternative hull materials. Conduct applied research related to critical S&T to investigate corrosion control modeling, high strength corrosion resistant compositionally complex alloys, corrosion resistant additive manufactured alloys and acoustic transduction technologies. MATERIALS AND PROCESSES: Continue development of 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. Continue design new microfluidic system for direct write additive manufacturing to significantly improve the existing techniques. Continue design of multifunctional material systems for use in new helmet design to mitigate multiple threats. Continue compositional modifications and processing parameters to optimize material performance have been demonstrated leading to current plans for their utilization. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: BIOCENTRIC TECHNOLOGIES ***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 2018 Plans:*** NAVAL BIOSCIENCE:	5.626	5.717	5.684	0.000	5.684

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 microbial 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. 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 Explosive Ordnance Disposal (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,					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
the Naval Medical Research Center and the Naval Medical Research Laboratories, for rapid identification of highly resistant bacterial pathogens.					
FY 2019 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. Continue development of microbial electronic devices. SYNTHETIC BIOLOGY FOR SENSING & ENERGY PRODUCTION: Continue research on synthetic biology studies of engineered sentinel organisms for environmental surveillance and integration of programmable cellular controllers with robotic devices. 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
develop electrosence and biosonar for Mine Counter Measures (MCM) and Explosive Ordinance Device (EOD) missions. MATERIALS AND CHEMISTRY: Continue development of novel approaches to rapidly identify antibiotic resistant genes in bacterial pathogens of importance for the entire US military force. Success of 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. A major success has been demonstrated by utilizing NRL developed microbial resistant determinant assay for its advances to system design. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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 2018 Plans:*** - Continue development of new, advanced, environmentally benign Anti-Fouling (AF)/Anti-Corrosive (AC) coating systems for Navy platforms. - Continue development of advanced environmentally sound technologies for shipboard waste treatment and pollution abatement systems. - Continue field evaluation of prototype robotic Hull BUG to identify gaps needed to refine and advance the technology for reduced drag, and significant fuel savings. - Complete studies on oil emulsion issues and development of novel bilge water treatment systems for existing and new ships. ***FY 2019 Base Plans:***	2.628	2.573	2.764	0.000	2.764

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue all FY 2018 efforts, less those noted to complete and expand research related to naval environmental technology. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: HUMAN FACTORS AND ORGANIZATIONAL DESIGN	5.085	5.159	5.777	0.000	5.777
Description: 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 2018 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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: 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 2019 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: Initiate development of warfighting experiments for information environment assessment, civil-military communications (public affairs), information operations and psychological operations. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change FY 2018 to FY 2019.					
Title: MEDICAL TECHNOLOGIES	6.420	6.465	5.839	0.000	5.839
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-					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 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 non-recompressive 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 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 non-recompressive 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. Continue 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: THE OFFICE OF NAVAL RESEARCH GLOBAL ***Description:*** 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 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 SN/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 2018 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 2019 Base Plans:*** Continue all FY 2018 efforts.	12.590	12.757	19.760	0.000	19.760

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
-ONR Global will support 28 PhD level scientists, in seven overseas offices, continuing to engage with international scientists and engineers through liaison visits to research institutions and continue actively fostering international collaboration by awarding research grants. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 2019 reflects the realignment of funds from PE 0601153N Defense Research Sciences to consolidate International Science Program support costs under single a program element.					
Title: TRAINING TECHNOLOGIES	4.891	4.960	4.918	0.000	4.918
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, 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 2018 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 neurobiology 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. Conduct field studies and user tests evaluating new features and job aiding tools. Research computational neuron-models in the design of training					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** COGNITIVE SCIENCE OF LEARNING: Continue research and associated efforts to assess advanced gaming technology for enhanced training. Continue experiments to validate automated performance assessment and after action reviews. Continue development a systematic program of applied research addressing unanswered questions regarding effective instructional strategies in artificially intelligent tutoring. Continue research the neurobiology of learning including integration of the role of white matter. Continue to develop games that incorporate artificial intelligence (AI) techniques to teach complex warfighter skills decision-making and problem solving. Continue work to develop optimal training strategies for intelligent jobs on mobile devices (e.g., IPad) and immersive environments for training interpersonal and leadership skills. Work to design and conduct experiment to assess training					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
effectiveness of intelligent tutor for training ship handling skills. Continue efforts to design features and develop novel psychometric approaches to assess human performance in medical/military simulations and simulators. Conduct field studies and user tests evaluating new features and job aiding tools. Continue research in computational neuron-models in the design of training systems. Conduct ongoing efforts to develop skill decay models for psychomotor, perceptual, and cognitive skills and refresher training strategies. Continue work to create intelligent avatars to interact with learners from different cultural, linguistic backgrounds, and preferences. Continue design scenarios generators that produce integrated (e.g.,individual and collective) training. Continue 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. Work to assess the improvement in recruit classification provided by the addition of measures of fluid intelligence and working memory. Continue efforts to understand the role of intrinsic motivation in facilitating the transfer of working memory training to other cognitive capabilities. Continue the study the efficacy of game-based brain training using hand-held (fieldable) hardware platforms. Continue work to 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. Continue development of software tools to facilitate building natural language tutorial dialogs for artificially intelligent tutoring. Continue integration of cognitive and neuron-computational models of human learning. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	45.629	48.649	56.197	0.000	56.197

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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 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-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602236N / *Warfighter Sustainment Applied Res*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	4.836	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.836

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	4.836	0.000
FY 2017 Accomplishments: SOCIAL NETWORKING: Analyze and develop social network models to create effective mitigation strategies of extremist groups. UNDERSEA MEDICINE: Mitigate the human challenges of the extreme maritime environment such as hyperbaric exposure, thermal regulation, nutrition/hydration in the field and optimize physical fitness for performance and injury prevention.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	4.836	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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	114.613	79.598	83.800	-	83.800	81.815	81.564	83.180	84.872	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	0.000	110.744	79.598	83.800	-	83.800	81.815	81.564	83.180	84.872	Continuing	Continuing
9999: *Congressional Adds*	0.000	3.869	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.869

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	118.941	79.598	80.951	-	80.951
Current President's Budget	114.613	79.598	83.800	-	83.800
Total Adjustments	-4.328	0.000	2.849	-	2.849
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-3.822	0.000			
• SBIR/STTR Transfer	-2.290	0.000			
• Program Adjustments	0.000	0.000	3.511	-	3.511

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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	-0.662	-	-0.662
• Congressional General Reductions Adjustments	-0.216	-	-	-	-
• Congressional Directed Reductions Adjustments	-2.000	-	-	-	-
• Congressional Add Adjustments	4.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Conformal Phased Array Antenna Research*	3.869	0.000
Congressional Add Subtotals for Project: 9999	3.869	0.000
Congressional Add Totals for all Projects	3.869	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.412 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

The funding increase from FY18 to FY19 reflects increased investment in the Anti-Tamper program.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Electromagnetic Systems Applied Research*	0.000	110.744	79.598	83.800	-	83.800	81.815	81.564	83.180	84.872	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: ELECTRONIC WARFARE TECHNOLOGY	63.696	44.008	43.605	0.000	43.605
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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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. - 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. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
capabilities indigenous to small UASs are a significant focus. Technology developments being addressed 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. - 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. ***FY 2019 Base Plans:*** Electromagnetic Warfare: The research being conducted is very diverse and 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 include 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
RF efforts include work in developing engineered high transmit to receiver materials for significant improvements in isolation. Efforts in devising means to degrade, disable or defeat operational communications networks is yielding promising results. Work is ongoing to expand EW jamming capabilities at high power levels covering previously unaddressed frequency bands with significant operational impact. 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. Interesting results have been obtained in ongoing research in metamaterials in the RF domain. There is a renewed focus on devising techniques to discover new methods of detecting, identifying, and cataloging threat emissions and also schemes to apply countermeasures using microjamming constellations 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: EO/IR SENSOR TECHNOLOGIES	5.137	7.078	7.102	0.000	7.102
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:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
a) Optically Based Terahertz (THz) and Millimeter Wave (MMW) Distributed Aperture Systems: 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 following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans: Electromagnetic Warfare: 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 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 for modest sized UAS platforms. A promising development using holographic-based optical phase conjugation to provide a wide field of view EO/IR countermeasures to detect, track and/or jam imaging sensors. An effort is expanding the state of the art in a short-wave infrared (SWIR) multispectral LIDAR system capable of simultaneous 4D (x,y,z,?) spatial-spectral information for imaging and spectral discrimination through obscurations to provide improved battlespace awareness through a revolutionary multi-functional electro-optical system for intelligence, surveillance, reconnaissance, target detection and classification. Continue electronics research efforts and thrusts on new 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.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue Materials and Chemistry focused research and thrusts on advanced 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 Conduct ongoing 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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: NAVIGATION TECHNOLOGY	7.038	6.120	6.110	0.000	6.110
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. ***FY 2018 Plans:*** Conduct 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 capabilities in the presence of emergent threats; Tactical grade atomic clocks that possess unique long-term					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 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 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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	12.427	11.040	15.524	0.000	15.524

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2018 Plans:*** Conduct 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 (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 2019 Base Plans:*** Electronics:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Explore and 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 Continue ongoing research efforts 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 (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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY 2018 to FY 2019 is due to a ramp up in funding towards the Anti-Tamper Program.					
Title: SURVEILLANCE TECHNOLOGY	9.424	8.998	9.093	0.000	9.093
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:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. 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). The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans: 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 ubiquitous transmissions and for the detection and discrimination of small UAS in a clutter filled environment. Additionally, technology development to enable full spectrum battlespace awareness through an ultra-wideband aperture for simultaneously 360 degree beamforming and low-profile ultra-low cross-polarization ultra-wide-band apertures to provide resilient electronic protection for Naval platforms. 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: VACUUM ELECTRONICS POWER AMPLIFIERS	2.655	2.354	2.366	0.000	2.366
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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
generation, large-signal and stability analysis to simulate device performance and improve the device characteristics. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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. 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 2019 Base Plans:*** Electronics Explore 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. Continue ongoing vacuum electronics efforts and increase investment in research associated with the exploration and development of 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 2019 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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 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 2018 Plans:*** N/A ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** 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	10.367	0.000	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	110.744	79.598	83.800	0.000	83.800

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602271N / *Electromagnetic Systems Applied Research*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	3.869	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.869

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Conformal Phased Array Antenna Research	3.869	0.000
FY 2017 Accomplishments: There have been substantive advances in Conformal Phased Array Antenna Research. The aim of this mark is to leverage the advances of conformal phased array antennae and its applications for improved aerodynamic capabilities of aircraft and for reducing the size and weight on manned aircraft and UAV's/UAS.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	3.869	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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	79.941	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	Continuing	Continuing
0000: *Ocean Wrfghtg Env Applied Res*	0.000	42.222	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	Continuing	Continuing
9999: *Congressional Adds*	0.000	37.719	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.719

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	42.618	42.411	45.132	-	45.132
Current President's Budget	79.941	42.411	42.998	-	42.998
Total Adjustments	37.323	0.000	-2.134	-	-2.134
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.073	0.000			
• SBIR/STTR Transfer	-1.751	0.000			
• Program Adjustments	0.000	0.000	-1.426	-	-1.426
• Rate/Misc Adjustments	0.001	0.000	-0.708	-	-0.708
• Congressional Add Adjustments	39.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *AGOR Mid-life Refit*	29.014	0.000
Congressional Add: *Naval Special Warfare Maritime Science and Technology*	4.836	0.000
Congressional Add: *Space-Based Monitoring in the Artic Basin*	3.869	0.000
Congressional Add Subtotals for Project: 9999	37.719	0.000
Congressional Add Totals for all Projects	37.719	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.150 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Ocean Wrfghtg Env Applied Res*	0.000	42.222	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Coastal Geosciences/Optics	6.604	7.904	8.019	0.000	8.019
Description: The goal of the Coastal Geosciences/Optics activity is to understand and predict the nearshore and coastal battlespace environment and its evolution. Studies address coupled phenomena affecting the hydrodynamical, geological, geophysical, and optical properties of the littorals through development of theory, predictive models and field measurement campaigns. Research results support safe and efficacious Naval Mine, Undersea, and Special Warfare operations.					
FY 2018 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 unmanned aerial vehicles (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 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 Continue to 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. Continuing developing 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue specification and development of sensors, signal processing, inversion, and other analysis tools when needed. ***FY 2019 Base Plans:*** Research investments in this activity support the development and testing of models, sensors, algorithm development and testing to enable prediction of coastal battlespace environments anywhere on the globe. Efforts include ocean color remote sensing to characterize bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties in the littorals and the demonstration of a compact hyperspectral imager to retrieve coastal environmental products from small UAVS. Additional efforts develop shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and though-the-sensor techniques to create operationally and tactically useful environmental descriptions of the littorals and sea bottom. Battlespace Environments: Continue to 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. Continue applied research 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. Continue specification and development of sensors, signal processing, inversion, and other analysis tools when needed. Undersea Warfare: Conceptualize and perform laboratory and field studies to understand and exploit energy storage and retrieval from the benthic interface and the potential to balance small scale and large scale intermittent power generation with power demand for persistent operation of marine sensors presently powered by batteries. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: Marine Mammals and Biology	3.519	3.407	3.630	0.000	3.630

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Description: The Marine Mammals and Biology activity 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. ***FY 2018 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 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 2019 Base Plans:*** Integrated Ecosystem Research: Continue research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Continue 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Effects of Sound: Continue research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. Continue 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. Continue 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 and characterize the relationship between the physiological stress response in marine mammals and acoustic exposure. Monitoring and Detection: Continue 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: Marine Meteorology	10.338	9.419	9.567	0.000	9.567
Description: The Marine Meteorology 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, Electric Magnetic (EM) and Electric Optical (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. ***FY 2018 Plans:*** 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;					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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 - Coupled Ocean/ Atmosphere Mesoscale Prediction System) 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 meteorology and oceanography (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 2019 Base Plans:*** 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. Studies encompass 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 processes and phenomena. These studies include efforts to develop appropriate inversion and other techniques to obtain atmospheric environmental data from airborne and spaceborne sensors. Research is coordinated with operational customers to enable rapid transition of research into operations. Initiate the					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Battlespace Environments: 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 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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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. NOPP topics address scientific problems that cross-agency missions, fall in gaps between agencies and/or are too large for any one agency to fund itself. ***FY 2018 Plans:***	8.626	8.611	8.781	0.000	8.781

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Further 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. Continue applied research activities to include conducting studies to develop an integrated coastal ocean observation system and associated sensors, communications, data acquisition, storage and processing tools. Continue efforts 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019					
Title: Ocean Acoustics ***Description:*** The Ocean Acoustics 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 has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic systems, are the shallow water, 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	2.288	2.060	2.074	0.000	2.074

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total

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.

FY 2018 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 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 2019 Base Plans:
Continue 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. Continue to provide ASW sensor 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. Continue efforts 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 2019 OCO Plans:
N/A

FY 2018 to FY 2019 Increase/Decrease Statement:

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
There is no significant change from FY 2018 to FY 2019.					
Title: Physical Oceanography	10.847	11.010	10.927	0.000	10.927
Description: The goal of the Physical Oceanography activity is to develop knowledge of the physics of the ocean within the battlespace environment to enable tactical naval use and exploitation of the battlespace. 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, Naval Special Warfare, and Mine and Expeditionary Warfare. ***FY 2018 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 unmanned underwater vehicles (UUVs)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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total

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.

The research is coordinated with operational customers to enable its rapid transition into operational systems.

FY 2019 Base Plans:

Conduct applied oceanographic research including field campaigns to study ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore environments. Data assimilation development extends use of coupled modeling approaches to include air-ice-wave-ocean-land models. Studies 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, and to fuse and exploit oceanographic data to create operationally useful information. Efforts continue to develop and test the Remote Ocean Sampling System for air-sea surface flux sampling as well as developing advanced autonomy for operations of gliders in extreme environments. Additional efforts 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 to maximize impact of the glider data in a high-resolution local forecast model for more accurate ocean predictions.

Battlespace Environments: A program 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. 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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. The research is coordinated with operational customers to enable its rapid transition into operational systems. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	42.222	42.411	42.998	0.000	42.998

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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	37.719	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.719

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: AGOR Mid-life Refit ***FY 2017 Accomplishments:*** AGOR 23 Class research vessel mid-life refit completed the major overhaul and service life extension of the third ship in the class, the AGOR 25 ATLANTIS. The overhaul replaced obsolete ship propulsion systems, enabled compliance with environmental regulations, increased efficiency and mission performance, and add up to fifteen years to the service life of the vessel. ***FY 2018 Plans:*** N/A	29.014	0.000
Congressional Add: Naval Special Warfare Maritime Science and Technology ***FY 2017 Accomplishments:*** Funds supported applied oceanographic research to exploit ocean currents, water surface and seafloor roughness, and ocean optoacoustical properties, among other phenomena, to enhance underwater vehicle and diver operations. ***FY 2018 Plans:*** N/A	4.836	0.000
Congressional Add: Space-Based Monitoring in the Artic Basin ***FY 2017 Accomplishments:*** Conducted remote sensing studies of ocean phenomena and related ocean/ atmosphere/ice/land interactions in the Arctic and northern latitudes. ***FY 2018 Plans:*** N/A	3.869	0.000
Congressional Adds Subtotals	37.719	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 9999 / *Congressional Adds*

E. Performance Metrics

Congressional Interest Items not included in other Projects.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	6.146	6.425	6.349	-	6.349	6.346	6.343	6.468	6.600	Continuing	Continuing
0000: *JT Non-Lethal Wpns Applied Res*	0.000	6.146	6.425	6.349	-	6.349	6.346	6.343	6.468	6.600	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: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	6.327	6.425	6.425	-	6.425
Current President's Budget	6.146	6.425	6.349	-	6.349
Total Adjustments	-0.181	0.000	-0.076	-	-0.076
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.161	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.076	-	-0.076
• Congressional General Reductions Adjustments	-0.020	-	-	-	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *JT Non-Lethal Wpns Applied Res*	0.000	6.146	6.425	6.349	-	6.349	6.346	6.343	6.468	6.600	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: (U) JOINT NON-LETHAL WEAPONS	6.146	6.425	6.349	0.000	6.349
FY 2018 Plans: - Continue academic research into technology areas with relevance to non-lethal weapon capabilities. - Continue investigations of alternative technologies with potential to address emerging capability gaps. - Continue to evaluate methodologies for measuring directed energy effects (millimeter - wave, high powered microwave, etc.) - Continue investigations of advanced materials and emergent technologies suitable for extended range non-lethal weapon payload applications. - Continue transition of foundational effects associated with advanced electro-muscular disruption technologies to higher levels of technology development and demonstration. - Continue feasibility assessment and evaluation of candidate technologies with potential to mitigate technology challenges impeding Non-Lethal Effects (NLE) capability gap resolution. - Continue applied research into characterization of non-lethal phenomena and assessment of human effects and weapon effectiveness, including development of dose response and injury correlates. - Continue investigation of component High Power Microwave (HPM) technologies and transition results to higher levels of technology development and demonstration.					
FY 2019 Base Plans: Continue research and investigation of emergent technologies and effects with the potential to address non-lethal counter-personnel and counter-materiel capability gaps. Some examples of counter-personnel research include feasibility studies and development of advanced electro-muscular incapacitation and directed energy					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
technologies (e.g., lasers, millimeter-waves) suitable for extended range applications. Investigation and initial design of component high power microwave system technologies and advanced materials for counter-materiel applications will continue in order to enable reduced system sizes, increased energy efficiency, improved performance, and increased delivery and employment options. Target susceptibility studies and evaluation of methodologies for measuring directed energy effects will also continue. Continue applied research to characterize non-lethal phenomena and assess target human effects and weapon effectiveness, including development of dose response and injury correlates for flash-bangs, millimeter-waves, blunt impact and electro-muscular incapacitation. Initiate exploration of new non-lethal effects and evaluation of innovative applications of existing technology to address future non-lethal capability needs. Transition results to higher levels of technology development and demonstration as feasibility is determined. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change between FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	6.146	6.425	6.349	0.000	6.349

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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	120.537	56.094	58.049	-	58.049	57.324	57.439	58.574	59.765	Continuing	Continuing
0000: *Undersea Warfare Applied Res*	0.000	120.537	56.094	58.049	-	58.049	57.324	57.439	58.574	59.765	Continuing	Continuing

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	126.313	56.094	58.008	-	58.008
Current President's Budget	120.537	56.094	58.049	-	58.049
Total Adjustments	-5.776	0.000	0.041	-	0.041
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-3.053	0.000			
• SBIR/STTR Transfer	-2.689	0.000			
• Program Adjustments	0.000	0.000	0.339	-	0.339

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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*			
• Rate/Misc Adjustments	0.000	0.000	-0.298	-	-0.298
• Congressional General Reductions Adjustments	-0.034	-	-	-	-

Change Summary Explanation

FY 2018 to FY 2019 funding increase represents increased investment and research associated with new sensor concepts to provide improved performance in smaller packages; automated passive acoustic & non-acoustic detection and classification algorithms to eliminate the dependence on traditional Anti-Submarine Warfare (ASW) platforms; undersea communications; secure and robust networking of autonomous sensors; and knowledge and exploitation of complex operational environment.

The FY 2019 funding request was reduced by $0.124 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Undersea Warfare Applied Res*	0.000	120.537	56.094	58.049	-	58.049	57.324	57.439	58.574	59.765	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: ANTI-SUBMARINE WARFARE (ASW) DISTRIBUTED SEARCH	28.695	15.274	15.154	0.000	15.154
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: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 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 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 2019 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 threat submarines; physics-based detection and classification algorithms with automation where possible; and knowledge and exploitation of the complex operational environment. Continue 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Undersea Warfare Conceptualize and perform laboratory measurements, field measurements, and theoretical/numerical analysis 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 such as: advancing sensing, onboard processing/decision making, and information sharing capabilities to enable multi-static ASW using multiple autonomous, coordinated and cooperating AUVs; the development of a new kind of underwater chemical sound source; and efforts that capitalize on structural acoustic features of UUVs and advance sonar design, sensing, and processing/decision making to enable high performance detection and classification of adversarial UUVs. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: ANTI-SUBMARINE WARFARE (ASW) PRECISION LOCALIZATION ***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 2018 Plans:*** Magnetic and Electric Field Sensing Conduct applied 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.	3.244	3.452	3.544	0.000	3.544

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Optical Sensing Conduct applied 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 2019 Base Plans:*** Continue focus on Magnetic and Electric Field Sensing applied research related to critical S&T for Precision Localization using magnetic and electric field sensing technologies. Execute research into novel methods to develop smaller and power efficient, high performance magnetic and electric field sensors. Pursue 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 will Conduct basic research related to critical S&T for Precision Localization using optical sensing technologies. Execute research to better exploit the information capacity available in photonic systems toward development of higher performance optical sensors. Pursue information theoretic optical sampling and telemetry characteristics to better support sensor performance and data integrity. Extend the effectiveness that photonic sensor operate across the air-water interface. Extend the distance optical sensors can effectively operate within the water column. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE	74.149	21.617	22.980	0.000	22.980
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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2018 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 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 2019 Base Plans:*** Undersea Warfare will continue 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 power-harvesting; underwater communications; networking of distributed autonomous sensors; and knowledge and exploitation of the complex operational environment. Conducting signal processing related research that focuses on combining information from multiple arrays in a distributed field that exploit new					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable science at sea. Undersea Warfare Conceptualize and perform laboratory measurements, field measurements, and theoretical/numerical analysis leading to non-platform-based and clandestine systems to provide ASW clandestine indications and warnings in far-forward and contested areas such as: 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; undersea communications; secure and robust networking of distributed autonomous sensors; and knowledge and exploitation of the complex operational environment. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2018 to FY 2019 funding increase represents increased investment and research associated with new sensor concepts to provide improved performance in smaller packages; automated passive acoustic & non-acoustic detection and classification algorithms to eliminate the dependence on traditional Anti-Submarine Warfare (ASW) platforms; undersea communications; secure and robust networking of autonomous sensors; and knowledge and exploitation of complex operational environment.					
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.	2.449	2.510	2.519	0.000	2.519

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 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 using technology to detect and classify marine mammals using a variety of fixed, towed, floating, and profiling platforms.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Integrated Ecosystem Research: Further research using animal tagging and passive acoustic monitoring to study behaviors, movement and distribution of marine mammals relative to key environmental properties (biotic and abiotic). Effects of Sound: Continue 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. Continue research into the mechanisms that enable marine mammals to dive to deep depths for long durations while mitigating, if not avoiding, health threats. Continue 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. Continue 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 using technology to detect and classify marine mammals using a variety of fixed, towed, floating, and profiling platforms. Models & Databases: Continue research to provide tools to support environmental compliance efforts and decision-making related to how marine mammals are affected by anthropogenic sounds. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
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	12.000	13.241	13.852	0.000	13.852

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 Plans:*** Conduct applied research related to critical S&T for supercavitation, advanced warheads, propulsion systems for undersea platforms and defense against undersea threats. ***FY 2019 Base Plans:*** Continue applied research related to critical S&T for supercavitation, advanced warheads, propulsion systems for undersea platforms and defense against undersea threats. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	120.537	56.094	58.049	0.000	58.049

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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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-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	152.427	156.805	147.771	-	147.771	155.625	168.512	181.877	185.572	Continuing	Continuing
0000: *(U)Future Naval Capabilities Applied Research*	0.000	152.427	156.805	147.771	-	147.771	155.625	168.512	181.877	185.572	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 objective of the work in this PE is to develop and mature technologies needed by the Navy and Marine Corps to initiate FNCs in PE 0603673N Future Naval Capabilities Advanced Technology Development that can be commenced at higher Technology Readiness Levels (TRLs). The FNC Program was restructured for FY19 to accelerate transition to the Fleet and Force. This restructuring involved a zero based review of all ongoing FNC projects where each effort was assessed for its technology maturity and transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some efforts were terminated and others were accelerated to achieve the goals of the restructured program. Funding for FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, is being resourced in PE 0603673N Future Naval Capabilities Advanced Technology Development. Funding for technology candidates at lower TRLs (3 to 4) is being resourced in this PE. ONR is working closely with the Resource Sponsors and acquisition stakeholders to develop high priority technological capabilities needed by the operational forces.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	165.103	156.805	158.197	-	158.197
Current President's Budget	152.427	156.805	147.771	-	147.771
Total Adjustments	-12.676	0.000	-10.426	-	-10.426
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.877	0.000			
• SBIR/STTR Transfer	-2.666	0.000			
• Program Adjustments	0.000	0.000	-9.700	-	-9.700
• Rate/Misc Adjustments	0.000	0.000	-0.726	-	-0.726
• Congressional General Reductions Adjustments	-0.133	-	-	-	-
• Congressional Directed Reductions Adjustments	-8.000	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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*

Change Summary Explanation

The FY 2019 funding request was reduced by $0.285 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *(U)Future Naval Capabilities Applied Research*	0.000	152.427	156.805	147.771	-	147.771	155.625	168.512	181.877	185.572	Continuing	Continuing

A. Mission Description and Budget Item Justification

Prior to FY19, the underlying FNC Program investments in this PE were aligned to specific FNC projects. In order to increase agility, exploit technology advances, and respond quickly to naval needs, future BA 2 investments supporting candidate FNC technologies are being developed in a more flexible manner. This approach facilitates an optimum response when developing and maturing the technology options that will be developed further in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. R-2 activities are now organized by the ONR Departments tasked to collaborate with the acquisition stakeholders and their resource sponsors. A complete accounting of the technology candidates being developed and a full disposition of each technology development effort referenced as continuing in the FY18 plans of this PE will be provided separately to the Congressional oversight committees.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: CAPABLE MANPOWER (CMP)	9.005	9.929	0.000	0.000	0.000
Description: The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. FNC: CMP-FY15-01 ACCELERATING DEVELOPMENT OF SMALL UNIT DECISION MAKERS (ADSUDM)					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. 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. FNC: CMP-FY18-01 LEARNING CONTINUUM AND PERFORMANCE AID (LCAPA)					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. FNC: CMP-FY19-03 Fleet Training Technologies (FleeT2) - Initiate FleeT2 - Conduct analyses of representational techniques, model dynamics, and high computational tractability. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: ENTERPRISE AND PLATFORM ENABLERS (EPE) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 Plans:*** FNC: EPE-FY14-02 ALUMINUM ALLOY CORROSION CONTROL AND PREVENTION - 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. - 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	9.142	13.708	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. FNC: EPE-FY15-03 SPECIAL HULL TREATMENT - Continue New Material(s) Development & Lab Characterization - Evaluate new material mitigation technology. 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. FNC: EPE-FY19-04 Signature Management System (SMS) - Continue SMS - Continue applied research technology development for submarine applications. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: EXPEDITIONARY MANEUVER WARFARE (EMW) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:***	2.731	0.000	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding decreased from FY17 to FY18 is due to FNC:EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT(HRDR) move that will continue in PE 0602131M Marine Corps Landing Force Technology.					
Title: FNC MANAGEMENT ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.	7.742	8.056	0.000	0.000	0.000
Title: FORCE HEALTH PROTECTION (FHP) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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.	5.290	4.308	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: FORCENET (FNT) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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	39.227	41.368	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. 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. 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 integrated air and missile defense. 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. - 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. FNC: FNT-FY16-01 BUGLE					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue Bugle - Continue applied research efforts supporting advanced waveforms. 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. - 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. 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. - 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. 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. FNC: FNT-FY17-04 RESILIENT HULL/INFRASTRUCTURE MECHANICAL & ELECTRICAL SECURITY (RHIMES) - Continue SCAMM - Develop information sharing capabilities for tactical platforms. - Continue SCRAM - Develop resilient software for integrated control systems, including those without redundant processors. 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)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. - 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 decision making. - Continue Propagation Channel Assessment and Prediction (PCAP) - Continue analyzing real-time techniques for assessing radio frequency propagation channels in support of naval operations. (***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: POWER AND ENERGY (P&E) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. 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.	10.890	11.038	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SEA SHIELD (SHD) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. - Continue Concept C Countermeasure - Conduct electronic subsystem software integration. 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.	38.865	40.074	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Complete Remote Command & Control - Finalize and document algorithm development and command and control functionality. - 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). 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. - Continue MCM Task Force Planning - Refine re-planning algorithms and integrate them with algorithms for the effects-based application of risk. 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. 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) - 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. FNC: SHD-FY16-07 SOFTKILL PERFORMANCE AND REAL-TIME ASSESSMENT (SPARTA)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue Softkill Performance and Real-Time Assessment (SPARTA) - Develop and establish design criteria, system requirements, and software requirements. 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. - 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. - 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. 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. FNC: SHD-FY18-08 FORCE-LEVEL INTEGRATED FIRES REAL-TIME ENGAGEMENT COORDINATION AND PERFORMANCE ESTIMATION (FIRECAPE) - Initiate FIRECAPE Algorithms - Begin development of performance estimation and coordination algorithms and validate their performance using Monte Carlo analysis against complex threat raids. 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. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SEA STRIKE (STK) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. 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. FNC: STK-FY15-02 ROTOR-CRAFT ADVANCED PROTECTION FROM IR/EO/RPG (RAPIER)	29.535	28.324	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 - Refine, test and finalize Infra-Red Countermeasures (IRCM) Electro-Optic/Infra-Red (EO/IR) techniques for flares and jammers using simulation and laboratory tests. 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. - Continue MUHV Sensors, Navigation and Guidance - Continue development and maturation of multiband and hybrid sonar, inertial navigation, and fiber-optic systems. 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. FNC: STK-FY17-04 ALPO - 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. - Continue Single Platform Coherent Arrays - Continue analyzing synchronized EW effects across intra-platform EW components. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: EMW AND COMBATING TERRORISM ***Description:*** The objective of this activity, new for FY19, is to develop and mature technologies in asymmetric and irregular warfare, distributed operations, information dominance, survivability and self-defense to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that: improve warfighter effectiveness in command, control, computers and communication for small unit naval expeditionary warfighters; enhance fires capabilities so warfighters employed in small, distributed units will have the tools they need to locate and decisively destroy larger enemy forces; improve force protection for small units and individual warfighters against a myriad of enemy attack modes; improve human performance by developing new training technologies, knowledge products, architectures, and systems that can accelerate mental, emotional and cognitive decision-making skill; mature emerging technologies for future intelligence, surveillance and reconnaissance systems; develop and mature new maintenance technologies for expeditionary combat systems; develop new expeditionary energy technologies that support distributed operations from the individual Marine to small units; develop novel technologies and innovative concepts that will improve the maneuverability of the Marine Corps Air Ground Task Force by enhancing the movement of troops and equipment from shipboard to inland objectives; and mature new technologies that will improve the standoff detection and neutralization of improvised explosive devices. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.	0.000	0.000	7.163	0.000	7.163
Title: C4ISR AND SPECIAL PROJECTS	0.000	0.000	71.913	0.000	71.913

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Description: The objective of this activity, new for FY19, is to develop and mature technologies in data science, mathematical optimization, computational and information sciences, quantum information sciences, electronics, command and control and combat systems, communications, cyber security, cyber operations, electronic warfare, sensing and surveillance, and precision timing and navigation, as well as technologies for surface and airborne vehicles, low observable (LO) technology, weapons system counter low observable (CLO) technology, and cruise missile defense weapons to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N,Future Naval Capabilities Advanced Tech Div. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that: advance techniques and algorithms for information processing and integration, information operations, information assurance, cyber protection , communications and networking, computational decision-making, and command and control technologies with a specific focus on enabling rapid, accurate decision making; exploit advancements in electronics, sensors and network technologies enabling new and innovative uses of the electromagnetic spectrum in areas of surface and aerospace surveillance, communications, electronic combat, and precision time and navigation; improve adaptive persistent surveillance capabilities; develop new digital radio frequency technologies supporting active aperture, phased arrays capable of performing multiple functions simultaneously; improve soft-kill performance and real-time assessment, as well as provide multiple means to detect and measure incoming threats. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: OCEAN BATTLESPACE SENSING	0.000	0.000	21.904	0.000	21.904
Description: The objective of this activity, new for FY19, is to develop and mature technologies in the areas of oceanographic and meteorological observations, modeling and prediction in the battlespace environment; submarine detection and classification, and mine warfare to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.					

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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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 Plans: N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that: improve the detection and neutralization of mines in both the ocean and littoral environment; exploit advancements in maritime sensing, ocean engineering, marine systems, and undersea signal processing, and improve our understanding of the environment and the limits of predictability by maturing technologies in fields ranging from the littoral geosciences to high latitude dynamics. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SEA WARFARE AND WEAPONS ***Description:*** The objective of this activity, new for FY19, is to develop and mature technologies that enable superior warfighting capabilities for surface and sub-surface naval platforms and undersea weaponry to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that: reduce the total life cycle cost of naval platforms and minimize the energy footprint of naval forces by exploiting advancements in hydrodynamics, survivability, electrical and thermal systems, platform structures and autonomy for unmanned surface vehicles; develop new functional and structural materials, materials processing and systems to fulfil the unique requirements of marine and military applications; develop concepts and technologies which enable flexible resilient logistics and maintenance: develop new guidance, control, autonomy, sensors, signal processing, undersea distributed network, energy conversion, propulsion and vehicle technologies that improve the capabilities of sea weapons; improve protection against corrosion and anti-fouling coatings; develop new battery, fuel cell, liquid and solid fuels, and motors for weapons and autonomous vehicles;	0.000	0.000	18.060	0.000	18.060

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
exploit renewable energy resources and energy efficiency technologies for sea warfare; develop concepts and technologies which enable flexible resilient logistics; develop improved and new acoustic sensors, and related processing and autonomy algorithms, to support long-range undersea weapons; and develop primary battery technology for long-range undersea weapons. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: WARFIGHTER PERFORMANCE ***Description:*** The objective of this activity, new for FY19, is to develop and mature technologies that enhance warfighter effectiveness and efficiency through bioengineered and bio-robotic systems, medical technologies, improved manpower, personnel, training systems design to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that: mature computational, neuroscience, bioscience, bio-mimetic, social/organizational, training, human factors, and decision making technologies to improve warfighter performance and decision making in all environments; exploit advancements in biomaterials, biomedical technologies, expeditionary and undersea medicine, physiology and biophysics, and immunology to increase the survival of casualties through intermediate, life-saving treatments and stabilization techniques and to prevent personnel injuries caused by the stresses of demanding Naval occupations and environments; and develop new manpower, personnel, training, and education technologies that prepare sailors and Marines to fight and win in an information rich, distributed battlespace, get the right warfighters into the right job at the right time with the right tools, and provide a 21st century learning environment designed to deliver the right training. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.000	0.000	8.756	0.000	8.756

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: NAVAL AIR WARFARE AND WEAPONS ***Description:*** The objective of this activity, new for FY19, is to develop and mature technologies in directed energy, energetic materials, autonomy, electromagnetic launch, and high speed conventional air and surface weapons to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N,Future Naval Capabilities Advanced Tech Div. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that enhance the offensive and defensive capabilities of tactical missiles and missile systems by developing and maturing new technologies in the areas of high threat time-critical strike, countermeasures to advanced seekers and hostile fire, air vehicle performance, air platform survivability, total ownership cost, operational availability, hypersonic missile defense, naval fires, non-kinetic warfare, unmanned naval aviation, warhead and propulsion energetics and design, navigation, autonomy, airframes, power and energy, propulsion design, sensors, seekers, targeting, directed energy, collaborative operations, advanced manufacturing and maintenance reduction. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.	0.000	0.000	19.975	0.000	19.975
Accomplishments/Planned Programs Subtotals	152.427	156.805	147.771	0.000	147.771

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

E. Performance Metrics

The performance metric for this PE and the research thrusts it funds can be measured by the number of successfully FNCs that are able to be proposed and selected in the FNC BA 3 PE.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	Continuing	Continuing
0000: *Mine & Exp Warfare Applied Res*	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	Continuing	Continuing

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	33.916	32.733	37.919	-	37.919
Current President's Budget	31.256	32.733	37.545	-	37.545
Total Adjustments	-2.660	0.000	-0.374	-	-0.374
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.058	0.000			
• SBIR/STTR Transfer	-0.602	0.000			
• Program Adjustments	0.000	0.000	-0.110	-	-0.110
• Rate/Misc Adjustments	0.000	0.000	-0.264	-	-0.264

Change Summary Explanation

The increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects.

The FY 2019 funding request was reduced by $0.152 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Mine & Exp Warfare Applied Res*	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: MINE TECHNOLOGY	2.504	3.777	8.293	0.000	8.293
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 increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects ***FY 2018 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 2019 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Initiate applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects.					
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). ***FY 2018 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.	17.283	17.754	17.969	0.000	17.969

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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-resolved LIDAR pulse propagation.					
FY 2019 Base Plans: Conduct applied research in novel minehunting technology areas that will ultimately enable unmanned systems to operate flexibly across a wide range of dynamic and unstructured environments and operations. Research thrusts include development of new algorithms, coding schemes, prototype hardware, and problem domain understanding for acoustic communications between unmanned MCM systems in the dynamic environments unique to minehunting; new transduction designs and sensor concepts appropriate for miniaturizing MCM capabilities onto substantially smaller unmanned systems and operating with increased autonomy; algorithmic approaches and new hardware designs that consolidate and optimize sensing, navigation, and communications for smaller autonomous mobile mine hunting and neutralization systems. Conclude development of a high source level projector that can extend the maximum detection range of the Low Frequency Broadband (LFBB) Mine Identification System. Conclude Phase 2 of Advanced Mission Module Technology Development. Conclude development of system concepts for wide area detection of surface and submerged drifting mines. Initiate joint sensing and communication approaches for multi-vehicle mine hunting. Initiate performance estimation for automatic target recognition on non-imaging systems. Continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable science at sea. Undersea Warfare: Perform laboratory, field, and theoretical/numerical studies that creates new solutions to enable naval forces to conduct more rapid and effective mine detection and classification such as: the development of unmanned underwater vehicle (UUV) autonomy to interactively sense and exploit the ambient environmental conditions to optimize performance; and to characterize the flow generated by biomimetic					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
propulsion approaches leading to development of tools to inform the design of future UUVs utilizing such propulsion mechanisms. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: MINE/OBSTACLE NEUTRALIZATION ***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 2018 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 sweep; and investigating the coupling of reacquire & identify capabilities with precision neutralization for buried mines. ***FY 2019 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 and beach zone mine and obstacle breaching concepts; techniques for neutralization of buried mines; techniques for emulation sweep; and investigating the coupling of reacquire & identify capabilities with precision neutralization for buried mines. Conclude development of system concepts for autonomous neutralization of surface and submerged drifting mines. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.439	0.428	0.445	0.000	0.445

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
There is no significant change from FY 2018 to FY 2019.					
Title: SPECIAL WARFARE/EOD	11.030	10.774	10.838	0.000	10.838
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 2018 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 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 2019 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 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. Conclude investigation of multi-modal signature reduction technologies for wet/dry-submersibles and semisubmersibles. Initiate modeling and development of concepts to increase mobility efficiency for combat divers. ***FY 2019 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	31.256	32.733	37.545	0.000	37.545

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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	171.146	159.697	-	159.697	161.381	161.309	164.499	167.844	Continuing	Continuing
0000: *(U)Innovative Naval Prototypes(INP) Applied Res*	0.000	0.000	171.146	159.697	-	159.697	161.381	161.309	164.499	167.844	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. 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 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 support further development. These investments are selected by a process that involves senior leadership in the Department of the Navy.

Developing INPs 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, such as concept exploration efforts, studies, investigations, and non-system specific technology efforts.

This PE was new for FY 2018 and it consolidated all Navy 6.2 investments funding INPs 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. Accordingly, the projects in the portfolio are no longer distinguished as INPs or Leap Ahead Technologies. Rather, they are now referred to simply as INPs.

Due to the nature of these projects, starting in FY19, plans have been written with limited details due to information security concerns. Specific information on each project will be provided separately to the Congressional oversight committees.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	0.000	171.146	160.349	-	160.349
Current President's Budget	0.000	171.146	159.697	-	159.697
Total Adjustments	0.000	0.000	-0.652	-	-0.652
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Rate/Misc Adjustments	0.000	0.000	-0.652	-	-0.652

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *(U)Innovative Naval Prototypes(INP) Applied Res*	0.000	0.000	171.146	159.697	-	159.697	161.381	161.309	164.499	167.844	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. It is intended that prototypes developed within this program, requiring both BA2 and BA3 funding, are demonstrated in a relevant environment to prove the feasibility of the new technological capability. The portfolio is periodically refreshed through the selection of new INPs as existing ones are completed. Successful experiments and 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 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.

Due to the nature of these projects, starting in FY19, plans have been written with limited details due to information security concerns. Specific information on each project will be provided separately to the Congressional oversight committees.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Cyber	0.000	24.923	29.147	0.000	29.147
Description: This R-2 Activity contains all BA2 Innovative Prototype (INP) investments that are developing new technologies for cyber warfare. Potential adversaries are investing in advanced technologies that will challenge our advantages in the critical information domain. Nation states and non-state actors seek to degrade our command and control capabilities, networks and computer systems. Cyber threats continue to grow and rapidly proliferate. Technologies developed in this R-2 Activity will enable the warfighter to take immediate, appropriate action at any time against any desired adversary, target or network by assuring that autonomous, continuous analyses of intelligence, persistent surveillance and open information sources have, at all times, optimized the possible courses of action based on commander's guidance. Technologies within this activity will foster operational endurance and enable sustained operations and resiliency for warfighters and platforms through enhanced cyber security/protection. ***FY 2018 Plans:*** Total Platform Cyber Protection (TPCP) Continue the TPCP project, previously funded predominantly in PE 0602123N Force Protection Applied Research. Develop leap-aheadresilient cybersecurity tools that will enable our warfighting platforms to fight					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Continue BA2 effort to develop leap-ahead resilient cybersecurity tools that will enable our warfighting platforms to fight through current and future cyber intrusions. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 increase is due to an increase in funding applied to the development of capabilities to provide cyber protection for two of the program's eight identified common layers of cyber platform functionality, in an effort to improve overall naval platform cyber resiliency and warfighting effectiveness.					
Title: Directed Energy / Electric Weapons ***Description:*** This R-2 Activity contains all BA2 Innovative Prototype (INP) investments that are developing new technologies for directed energy and electric weapons. Future adversaries will seek to neutralize U.S. conventional advantages by capitalizing on asymmetric capabilities that incorporate mobility, range, speed and deception. Naval platforms will be on the front line of our national integrated defensive capabilities to defeat these emerging threats that are proliferating. At the same time, the fleet/force must be able to effectively strike targets with survivable, scalable and cost-effective weapons that have sufficient range, speed and accuracy to complete a variety of missions while reducing risk to our warfighters and without creating unnecessary collateral	0.000	57.475	45.788	0.000	45.788

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
damage or loss of life. Technologies within this activity will provide scalable lethality through enabling multi-domain, integrated, scalable kinetic and non-kinetic systems for offensive of defensive purposes. ***FY 2018 Plans:*** Electro-Magnetic Railgun (EMRG) Continue EMRG, previously funded in PE 0602114N Power Projection Applied Research and PE 0602123N Force Protection Applied Research. The EMRG capability will support Naval Surface Fires, Integrated Air and Missile Defense (IAMD), Fast Attack Craft and Fast Inshore Attack Craft (FAC/FIAC) defense 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, and Anti-Surface Warfare (ASuW) missions. The capability will electromagnetically launch a projectile with sufficient kinetic energy to travel significantly farther than traditional Naval gunfire. High-power Joint Electromagnetic Non-Kinetic Strike (HIJENKS) Continue HIJENKS, a joint USAF/USN project previously funded as a FY17 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:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 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. Solid State Laser Technology Maturation (SSL TM) Complete the BA2 portion of SSL TM, which was previously funded in PEs 0602114N Power Projection Applied Research. Complete development of the maritime laser weapons system prototype components and test them in the prototype system on a representative test platform for a naval surface combatant. Complete the required laser weapon system component engineering, design, integration and testing necessary to have a testable, experimental prototype. ***FY 2019 Base Plans:*** Continue conducting BA2 development addressing the unique technical challenges inherent in the construction, assembly and operation of a high-power, kinetic energy weapon prototype capable of repeatedly launching long range, precision guided projectiles using electricity instead of chemical propellants. Continue BA2 efforts to develop a radio frequency effects payload (a joint USAF/USN project) with scalable electromagnetic effects.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Initiate development of a government laboratory laser testing environment that is representative of a shipboard environment. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease is due primarily to the completion of operational laser weapon system applied research. The majority of the laser work in this effort continues or is being conducted in BA3 PE 0603801N Innovative Naval Prototypes Advanced Technology Development.					
Title: Electromagnetic Maneuver Warfare ***Description:*** This R-2 Activity contains all BA2 Innovative Prototype (INP) investments that are developing new technologies for Electromagnetic Maneuver Warfare (EMW). The electromagnetic spectrum is a key operational maneuver space enabled by continuous, real-time awareness of all spectrum activity. This R-2 Activity supports spectrum dominance which included efforts that focus on communications, surveillance, EW and electronics to understand and shape the battle space. The ability to assure access to the full spectrum is essential for battle space awareness and threat surveillance/weapon sensor engagement. Technologies within this activity will provide for integrated and distributed forces capable of dynamic synchronized actions through interoperable forces by incorporation of autonomous / disaggregated systems to increase flexibility and reach within the electromagnetic spectrum. ***FY 2018 Plans:*** Electromagnetic Maneuver & Control Capability (EMC2) Continue the EMC2 project, previously funded in PE 0602271N Electromagnetic Systems Applied Research, 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	24.086	11.072	0.000	11.072

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Nemesis Complete the Nemesis project, previously funded in PE 0602271N Electromagnetic Systems Applied Research, 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 ***FY 2019 Base Plans:*** Continue BA2 efforts to develop technology which will enable a strike group to work cooperatively in the Electromagnetic Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), communications, and radar performance. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease is due primarily to the completion of Nemesis, a distributed EW systems project.					
Title: INP Management ***Description:*** This R-2 Activity was discontinued in FY19. ***FY 2018 Plans:*** INP Management Continue INP Management Support/OPS Analysis, previously funded in PE 0602747N Undersea Warfare Applied Research. Conduct applied research and analysis, including technology management of Innovative Naval Prototypes (INP) investments supporting Department of the Navy priorities for emerging technologies of a disruptive and game changing nature. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.000	1.500	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The FY18 to FY19 decrease was due to movement of the funds into the Directed Energy / Electric Weapons Activity.					
Title: Undersea Warfare	0.000	14.732	13.602	0.000	13.602
Description: This R-2 Activity contains all BA2 Innovative Prototype (INP) investments that are developing new technologies for Undersea Warfare. This R-2 Activity explores development of technologies to achieve and maintain undersea dominance in the areas of ASW and mine warfare, and to improve environmental sensing capabilities which support the Undersea Warfare domain. Technologies within this activity will dramatically improve sensing and sense-making, provide integrated and distributed autonomy to forces, and provide scalable lethality through development of kinetic and non-kinetic effects payloads. ***FY 2018 Plans:*** Forward Deployed Energy & Communications Outpost (FDECO) Complete the FDECO project, previously funded in PE 0602747N Undersea Warfare Applied Research. Complete 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. Anti-Submarine Warfare Mission Packages (ASW MP) Complete ASW MP, previously funded in PE 0602747N Undersea Warfare Applied Research. The ASW MP is developing a set of ASW sensors and autonomy algorithms. Affordable Mobile ASW Surveillance System (AMASS) Initiate AMASS, a two year project that will verify our understanding of the physical phenomenon postulated to give superior performance. Design source and receiver configurations suitable for future spiral development as					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
an autonomous deployable system. The first of three units will be fabricated and assembled, and fabrication and assembly of the second and third unit will begin. Develop software for real time control of the source and post-test control of the receiver. Develop software to analyze data that will be collected. ***FY 2019 Base Plans:*** Complete BA2 efforts to verify performance of components to enable next generation ASW capability. Initiate BA2 efforts to develop the technology required to operate an unmanned environmental observing system in strategically important locations in support of persistent monitoring of environmental conditions. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease is due primarily to the completion of an undersea warfare project for sustained USV operations, offset by the initiation of an undersea warfare environmental observing system.					
Title: Unmanned and Autonomous Systems	0.000	48.430	60.088	0.000	60.088
Description: This R-2 Activity contains all BA2 Innovative Prototype (INP) investments that are developing new technologies for Unmanned and Autonomous Systems. Increased proliferation of inexpensive lethal threats targeting individual warfighters and high-value assets, combined with continued rapid advances in computing, power and energy, robotics, sensors and position guidance technologies, drives the requirement to augment expensive manned systems with less expensive, unmanned, fully autonomous systems that can operate in all domains. Technologies within this activity will provide integrated and distributed, autonomous and disaggregated systems to increase flexibility and reach. ***FY 2018 Plans:*** 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 technologies, specific attention will be directed toward the task of integrating them into a full scale autonomous platform to increase their technology readiness level.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Claws Continue Claws. Claws, which was previously funded in 0602747N Undersea Warfare applied Research will develop the autonomy required to operate large and extra-large Unmanned Undersea Vehicles (UUVs) in an anti-access, area-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. 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. 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 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. 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. Medium Displacement Unmanned Surface Vehicle (MDUSV) Continue MDUSV, which was previously funded in 0602123N Force Protection Applied Research and PE 0602747N Undersea Warfare 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 technologies are being designed and developed for an MDUSV prototype that will be capable of performing multiple autonomous missions over extended periods of time. Tern Complete Tern, a joint ONR and DARPA project, previously funded in 0602123N Force Protection Applied Research.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Complete the maturation of technology addressing integration challenges associated with developing a Vertical Take-Off and Landing (VTOL) UAV capability. USV Swarm Continue USV Swarm, which was previously funded in PE 0602271N Electromagnetic Systems Applied Research and PE 0602747N Undersea Warfare Applied Research. Conduct applied research into cooperative autonomy for unmanned surface vehicle swarms including task allocation, route planning and perception. ***FY 2019 Base Plans:*** Continue applied research of autonomous payloads for large and extra-large unmanned undersea vehicles. Continue applied research of autonomy algorithms, the command and control architecture needed for swarm control (a flying ad-hoc network), effects payloads and sensing modalities. Continue applied research of autonomous control for unmanned surface systems, focusing on research into common behaviors across multiple missions, advancements in route planning, and additional perception modalities. Complete applied research to include an at-sea demonstration of a fuel cell system on an available UUV of suitable size. Continue BA2 to conduct applied research into multi-USV autonomous control, including research into common multi-USV behaviors across multiple missions, multi-USV task recognition/allocation/execution and advanced perception. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The overall FY18 to FY19 increase is due to the ramp up of funding in the second year of two FY18 new start INPs and an increase in funding for autonomy maturation efforts in support of unmanned surface craft					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
operations, countered by a reduction of funding levels associated with the completion of three unmanned and autonomous systems technology development projects.					
Accomplishments/Planned Programs Subtotals	0.000	171.146	159.697	0.000	159.697

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 Program Element (Applied Research associated with the Innovative Naval Prototypes (INP) Program) 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. Technology development is informed by periodic interaction with Naval warfighters, resource sponsors and the acquisition community. At the lowest level, each project is evaluated against technical and financial milestones on a 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 is briefed on the portfolio's status by the Chief of Naval Research.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	62.722	64.418	-	64.418	65.790	67.001	68.396	69.751	Continuing	Continuing
0000: *(U)Science & Tech Management - ONR Field Acts*	0.000	0.000	62.722	64.418	-	64.418	65.790	67.001	68.396	69.751	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	0.000	62.722	64.236	-	64.236
Current President's Budget	0.000	62.722	64.418	-	64.418
Total Adjustments	0.000	0.000	0.182	-	0.182
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Rate/Misc Adjustments	0.000	0.000	0.182	-	0.182

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 budget activity 2 and improves reporting of Navy's S&T investment by including S&T management as part of the S&T topline.

The funding increase from FY18 to FY19 reflects the transfer of personnel and associated labor costs from Operation and Maintenance, Navy (O&M,N) BA 4 Administration (4A1M) for the proper alignment of funding for the Human Research Protection Program (HRPP).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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*

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *(U)Science & Tech Management - ONR Field Acts*	0.000	0.000	62.722	64.418	-	64.418	65.790	67.001	68.396	69.751	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: (U) Science & Tech Management - ONR Field Acts	0.000	62.722	64.418	0.000	64.418
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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 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 2019 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the transfer of personnel and associated labor costs from Operation and Maintenance, Navy (O&M,N) BA 4 Administration (4A1M) for the proper alignment of funding for the Human Research Protection Program (HRPP).					
Accomplishments/Planned Programs Subtotals	0.000	62.722	64.418	0.000	64.418

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	28.447	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.447
0000: *(U)Science & Tech Management - ONR Headquarters*	0.000	28.447	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.447

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	29.575	0.000	0.000	-	0.000
Current President's Budget	28.447	0.000	0.000	-	0.000
Total Adjustments	-1.128	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.128	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *(U)Science & Tech Management - ONR Headquarters*	0.000	28.447	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.447

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: (U) Science & Tech Management - ONR Headquarters	28.447	0.000	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. ***FY 2018 Plans:*** Funds transferred to 0605898N Management HQ - R&D ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** 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.					
Accomplishments/Planned Programs Subtotals	28.447	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	97.122	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	97.122
2911: *Power Proj Adv Tech*	0.000	97.122	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	97.122

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	96.406	0.000	0.000	-	0.000
Current President's Budget	97.122	0.000	0.000	-	0.000
Total Adjustments	0.716	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.301	0.000			
• SBIR/STTR Transfer	-2.585	0.000			
• 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 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.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
2911: *Power Proj Adv Tech*	0.000	97.122	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	97.122

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: PRECISION STRIKE TECHNOLOGY	97.122	0.000	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 2018 Plans:*** N/A ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** 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.					
Accomplishments/Planned Programs Subtotals	97.122	0.000	0.000	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	83.146	26.342	2.423	-	2.423	2.447	2.503	2.518	2.561	Continuing	Continuing
2912: *Force Protection Advanced Technology*	0.000	41.810	23.568	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	65.378
3049: *Force Protection*	0.000	2.650	2.774	2.423	-	2.423	2.447	2.503	2.518	2.561	Continuing	Continuing
9999: *Congressional Adds*	0.000	38.686	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.686

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) Project 2912 to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, in the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Surface Ship and Submarine Hull Mechanical and Electrical, and Aircraft Technology research efforts.

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 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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	48.438	26.342	37.032	-	37.032
Current President's Budget	83.146	26.342	2.423	-	2.423
Total Adjustments	34.708	0.000	-34.609	-	-34.609
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.192	0.000			
• Program Adjustments	0.000	0.000	-34.258	-	-34.258
• Rate/Misc Adjustments	0.000	0.000	-0.351	-	-0.351
• Congressional Directed Reductions Adjustments	-3.100	-	-	-	-
• Congressional Add Adjustments	40.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *Autonomous Surface Unmanned Vehicle Research*	38.686	0.000
Congressional Add Subtotals for Project: 9999	38.686	0.000
Congressional Add Totals for all Projects	38.686	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2912: *Force Protection Advanced Technology*	0.000	41.810	23.568	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	65.378

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2912 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Surface Ship & Submarine Hull Mechanical & Electrical (HM&E), and Aircraft Technology research efforts.

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 situational awareness (SA) and standoff advantage without reducing forward presence and; provide endurance for unmanned systems necessary for force multiplication in an anti-access/area denial (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, anti-submarine warfare (ASW) and electronic warfare (EW) missions; it will introduce larger unmanned surface vehicles (USV) to the Navy; and it will introduce advanced autonomy to the surface Navy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E)	13.283	17.546	0.000	0.000	0.000
Description: Activity includes: advanced technology demonstrations to evaluate emerging energy technologies and advanced technology development for Unmanned Sea Surface Vehicles (USSV) in support of Naval S&T Focus Area on Autonomy and Unmanned Vehicles. ***FY 2018 Plans:*** -Conduct advanced research related to critical S&T for development of autonomous navigation for USVs 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 MDUSV effort to demonstrate					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY 2018 to FY 2019 reflects the realignment of the funding for Surface Ship & Submarine Hull Mechanical & Electric (HME) to PE 0603671N Navy Advanced Technology Development.					
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. ***FY 2018 Plans:*** - Continue the advanced technology development efforts and demonstrations of the 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 TACAIR ISR systems. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:***	28.527	6.022	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY 2018 to FY 2019 reflects the realignment of the funding for Aircraft Technology to PE 0603671N Navy Advanced Technology Development.					
Accomplishments/Planned Programs Subtotals	41.810	23.568	0.000	0.000	0.000

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 FDECO INP effort, the overall goals is the development of technologies which focus on energy management and transfer technologies that enable persistent undersea operations by unmanned vehicle (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 and 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 collision regulations (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: PB 2019 Navy											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
3049: *Force Protection*	0.000	2.650	2.774	2.423	-	2.423	2.447	2.503	2.518	2.561	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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Title: EMERGING THREATS	2.650	2.774	2.423	0.000	2.423
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 2018 Plans:*** - Continue development of lower cost/higher performance Force Protection sensors and automated detection algorithms, and decision support tools. - Continue research to reduce force protection manpower and equipment costs through automation and predictive learning algorithms. -Continue threat characterization research and perception experiments for sensor performance optimization and model development and validation. - Continue development of all weather sensors optimized for installation of force protection. - Continue research into sensors for use in counter-surveillance around protected facilities. - Continue research to advance sensor fusion capabilities in high density networks with diverse sensor grids.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue development of assessment algorithms and information analysis technologies to augment skills or replace persons in operations centers. - Continue interim demonstration of acoustic sensors for perimeter and area surveillance in realistic environments. - Continue development of protection technology for naval installation power and energy infrastructure. - Continue research in non-acoustic detection, tracking, classification, engagement of underwater threats to naval installations. - Continue development of autonomous unmanned harbor defense systems for perimeter patrol and threat interdiction. - Continue research into automated vehicle entry control point monitoring, automatic vehicle classification, risk assessment and logic system decision making. - Continue development of non-contact biometric verification technologies to support unmanned automated access control systems. - Continue and expand development of Virtual Inductive Loop technology to include pedestrians, two wheeled vehicles, and multi-lane automated gates - 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.					
FY 2019 Base Plans: Finish development and conduct full demonstration of Virtual Inductive Loop technology to include automated perimeter surveillance in the region of the entry control point. Replacing in ground inductive loops with video based virtual inductive loops will improve reliability and performance and reduce maintenance costs associated with Naval Facilities Engineering Command (NAVFAC) automated gates.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Ongoing development of Autonomous Maritime Asset Protection capabilities for detection, classification, and defeat of small unmanned air, surface, and subsurface threats to naval installations through fusion of electro-optic sensors, acoustic sensors and countermeasures technologies demonstrated under this program. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease in funding and reduced program costs from FY2018 to FY2019 is associated with the completion of the Virtual Inductive Loop technology effort.					
Accomplishments/Planned Programs Subtotals	2.650	2.774	2.423	0.000	2.423

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.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603123N / *Force Protection Advanced Technology*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	38.686	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.686

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Autonomous Surface Unmanned Vehicle Research	38.686	0.000
FY 2017 Accomplishments: Funds executed to further research and support for Autonomous Surface Unmanned Vehicles, including design and fabrication of a second SEA HUNTER (MDUSV) hull.		
FY 2018 Plans: N/A		
Congressional Adds Subtotals	38.686	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: PB 2019 Navy												Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	25.726	9.360	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.086
2913: *Electromagnetic Systems Advanced Technology*	0.000	25.726	9.360	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.086

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all FY19 planned continuing and initiating research associated with the Electronic and Electromagnetic Systems and Global Positioning System and Navigation Technology research efforts.

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

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: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	26.421	9.360	8.804	-	8.804
Current President's Budget	25.726	9.360	0.000	-	0.000
Total Adjustments	-0.695	0.000	-8.804	-	-8.804
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.679	0.000			
• Program Adjustments	0.000	0.000	-8.804	-	-8.804
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions Adjustments	-0.016	-	-	-	-

Change Summary Explanation

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all FY19 planned continuing and initiating research associated with the Electronic and Electromagnetic Systems and Global Positioning System and Navigation Technology research efforts.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2913: *Electromagnetic Systems Advanced Technology*	0.000	25.726	9.360	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.086

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all FY19 planned continuing and initiating research associated with the Electronic and Electromagnetic Systems and Global Positioning System and Navigation Technology research efforts.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: ELECTRONIC AND ELECTROMAGNETIC SYSTEMS	16.565	5.269	0.000	0.000	0.000
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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2018 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433.					
Title: GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY	2.800	4.091	0.000	0.000	0.000
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 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433.					
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.	6.361	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. This R2 activity was initiated in PE 0602271N Electromagnetic Systems Applied Research and expanded in FY 2015 to PE 0603271N Electromagnetic Systems Advanced Technology. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** 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.					
Accomplishments/Planned Programs Subtotals	25.726	9.360	0.000	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	137.190	154.407	150.245	-	150.245	142.377	141.111	143.901	146.829	Continuing	Continuing
2223: *Marine Corps ATD*	0.000	91.213	94.664	103.176	-	103.176	94.386	93.146	94.988	96.920	Continuing	Continuing
2297: *Futures Directorate*	0.000	45.977	59.743	47.069	-	47.069	47.991	47.965	48.913	49.909	Continuing	Continuing

A. Mission Description and Budget Item Justification

This PE addresses demand signals emphasized by the Commandant of the Marine Corps, the Chief of Naval Operations, and the Chief of Naval Research, as well as those pulled from dynamic engagement with stakeholders. Research efforts are carefully selected to ensure they have the potential to expand warfighting capabilities, inform operational concepts and requirements development, and advance state of the art technology and scientific knowledge. Current guidance also highlights the need to accelerate our pace of development and guide the approach to rapid experimentation, prototyping, and learning.

As reflected in the Marine Corps Operating Concept, the current strategic guidance from the Commandant, expeditionary forces will conduct maneuver warfare in environments characterized by complex terrain, technology proliferation, information used as a weapon, a battle of signatures, and an increasingly contested maritime domain. Additionally, an emergent operation stressor is the contested urban environment which exemplifies the characterizations listed above. The urban environment is one of the most complex terrains with physical compartmentalization and canalization, additional physical dimensions (subterranean and multi-story structures), crowded conditions and associated threat obscuration, communications challenges, informational and human aspects, and proliferation of observation and fires technologies. This environment requires capabilities addressing all the activities within this PE and while it provides many challenges, unique opportunities are also presented and can further shape technology approaches.

These future challenges and portents demand robust technologies for the Marine Corps, but the technology options are constrained. They must have a lightweight deployable character, and the ability to operate in austere conditions with little fixed infrastructure or support while retaining the agility and lethality of an integrated maneuver force. Technology must provide full spectrum capability against robust and complex peer and near-peer adversaries while meeting size, weight, power, cost (SWAP-C) limitations, and information availability within distributed, intermittent and limited (DIL) environments.

The approach within this PE encompasses ideas that support both revolutionary and evolutionary capabilities, and in this way considers and balances both "push" and "pull" aspects of technology projects. This PE matures technologies emerging from PE 0602131M to develop concept prototypes and initial experimentation to confirm feasibility in an environment relavent to 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: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	140.416	154.407	142.368	-	142.368
Current President's Budget	137.190	154.407	150.245	-	150.245
Total Adjustments	-3.226	0.000	7.877	-	7.877
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.137	0.000			
• Program Adjustments	0.000	0.000	0.000	-	0.000
• Rate/Misc Adjustments	0.000	0.000	7.877	-	7.877
• Congressional General Reductions Adjustments	-0.089	-	-	-	-

Change Summary Explanation

The FY 2019 funding request was reduced by $0.701 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2223: *Marine Corps ATD*	0.000	91.213	94.664	103.176	-	103.176	94.386	93.146	94.988	96.920	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds advanced research; technology demonstration, experimentation, and prototyping; and more technologically mature projects within the Future Naval Capability (FNC) process as means to inform, enhance, enable, and invent future concepts and capabilities with new S&T. This project is organized into ten activities, the core of which is represented by the eight Expeditionary Warfighting Capability Areas.

Emphasized within this project are increased efforts to actively demonstrate advanced technologies and system concepts. These demonstrations and experiments focus on the specific technologies, not necessarily their operational application, and vary based on the technical maturity of the project. This early technology exposure gives Marines a view into the future and enables them use their imagination and innovation to envision novel employment of the technology and inform the acquisition process.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS (C4)	6.790	7.500	6.480	0.000	6.480
Description: This activity investigates robust, resilient, and secure networked communications pathways and capability that support an expeditionary force's distributed and disaggregated operations. Research supports both networked and local computation for communications that exploits the expeditionary forces close physical proximity to threats while mitigating shortfalls commiserate within distributed, intermittent, and limited (DIL) environments. Expeditionary forces must operate in the cyber domain and in addition to defending communications networks, vehicles, and weapons systems, are reliant on electronic controllers for basic operations and as such are susceptible to cyberattacks. Technologies addressed within this activity include secure, robust, self-forming, mobile communications networks; distributed computing to support information dissemination to all echelons; improved capabilities in over-the-horizon, beyond line-of-sight, and restricted environment communications and sensors; and software and data processing to support formation of an appropriate common picture. Other efforts include power management, low detectability, conforming to SWAP-C constraints, and interoperability within the joint environment. Further, this activity integrates and demonstrates enhanced communications and situational awareness capabilities in experimental and warfighting environments reflecting USMC operations. Advanced technology resources will be developed and applied to complement commercial, other service, and defense agency					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
investments to produce a technology base addressing identified Marine Corps technology gaps. Focus will be on developing component level prototypes and experimentation in relevant environments. ***FY 2018 Plans:*** - Continue urban navigation with limited Global Positioning System availability demonstrations. - Continue demonstrations of improved urban communications capabilities. - Continue Advanced HF Antenna effort. - Initiate Advanced Cryptography Technology. - Initiate Adaptive Distributed Messaging. - Transfer all Tactical Cyber Warfare efforts to the Expeditionary Cyber Activity. ***FY 2019 Base Plans:*** The C4 research effort focuses heavily on the continued development and integration of multiple underlying technologies into subsystems and system with the purpose of demonstrating the tactical exploitation of information and the electromagnetic spectrum. To address resiliency requirements of C4 this effort is closely coordinated with the Expeditionary Cyber research portfolio also described herein so as to most efficiently exploit multifunction capabilities in portable reduced SWAP-C systems. This integrated rapid co-design, prototyping, and experimentation approach will reduce time needed to provide new capabilities to the US Marine Corps. Developed and demonstrated technologies will include signature management, interoperability, spectrum maneuver, damage assessment monitoring, and information dominance for tactical edge systems. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY2018 to FY2019 is due to reduced investment in C4ISR technologies and increased investment in ISR and Expeditionary Cyber technologies and associated Project Unit Activities in accordance with projected funding requirements and phasing across other Marine Corps ATD objectives and activities.					
Title: FIREPOWER ***Description:*** The activity investigates a large variety of weapons to provide the warfighter with a decisive, yet surgical, tactical advantage to collectively address 21st-century combined-arms warfare against peer and near-peer states. Research efforts increase the reach, lethality and capacity, while retaining mobility and tempo beneficial to expeditionary maneuver warfare. Maintaining focus on size, weight, power, cost (SWAP-C) and distributed, intermittent and limited (DIL) environments stresses the technical solutions available.	8.326	8.558	16.955	0.000	16.955

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
This activity furthers the maturity of researched technology solutions by also developing the integration required to effectively demonstrate and test emergent capabilities. Achieving a true combined arms state involves a full systems approach for both kinetic and non-kinetic capabilities all driven by a holistic targeting capability. 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, targeting, launch/ propulsion, lethality, and accuracy. ***FY 2018 Plans:*** - Continue development of targeting and engagement technologies for distributed operations collaborative fires integration and demonstrations. - Continue 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. - Continue Engineering and Development portion of Awareness for Lightweight Engagements and Remote Targeting (ALERT) to develop large aperture, lightweight lens with enhanced fields of view. - Continue 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. - Continue 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. - Continue development of precision fires engagement technologies, to include trajectory shaped 81mm mortars, 83mm missiles, and smaller precision munitions. - Initiate High Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) to include projectile integration, lethality enhancement, fuze setting integration and aerodynamic and aerospace technologies. - 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 2019 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
This activity will finalize development of direct electrical ignition for caseless small caliber ammunition for integration and testing. Development of fuzing and sensor technologies for cannon-delivered area effects munitions will continue. Systems engineering of supervised-autonomous weapon system control will continue, implementing engagement logic, to develop and demonstrate the key enabling technologies and command and control methods for weaponized unmanned ground vehicles. Efforts will include prototype weapon systems for technical evaluation. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY 2018 to FY 219 supports development of the High Reliability Dual Purpose Improved Conventional Munitions (DPICM) Replacement (HRDR) program to increase the reliability of cluster munitions, which will lead to increased lethality while reducing collateral damage.					
Title: FORCE PROTECTION ***Description:*** This activity investigates new ways and means to protect forces and materiel across all operational settings, from contested sea-land surface interfaces to complex urban environments. The portfolio protects against adversaries' challenges such as guided-rockets and missiles, mobile coastal artillery, threat EW, and counter-ISR. Mines and obstacles both in the water and ashore also complicate amphibious landings. The activity invests in vehicle survivability aspects that are exacerbated due to SWAP-C constraints inherent to Marine Corps operation and the harsh nature of the amphibious environment. Technologies addressed include lightweight armor for ballistic and underbody blast protection, advanced sensors for counter tactical surveillance, active protection, and signature management. This activity also considers technology for payloads, packages and sensors that are needed by amphibious vehicles (both manned and unmanned) including mine counter measures; explosive hazard defeat systems; and obstacle and threat detection systems as well as technologies for improved protection for individuals against blast, ballistic and blunt impact threats. ***FY 2018 Plans:*** - Continued development of technologies to defeat side/top attack and advanced fuze mines through signature reduction and advanced signature duplication. - Continue development of technologies to locate and defeat IEDs.	10.474	10.043	10.794	0.000	10.794

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue development of technologies to defeat advanced mine fuzes (seismic, acoustic, and infrared). - Continue demonstration of laser technology readiness for battlefield employment. - Continue 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. - Continue a program to demonstrate the fusion of multiple modes of detection of explosive hazards into a single system. - Continue development of materials and helmet systems that absorb/dissipate blast shock waves. - Continue 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. - Continue 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. - Continue 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. - Continue a project to investigate the detection and neutralization of explosive hazards in multiple, diverse, environments. - Continue a program to fuse multiple technologies that will detect and classify tactical surveillance and targeting threats before engagement from a moving platform. - Continue 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. - 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. - 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.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 2019 Base Plans:*** This activity is focusing efforts on integrating and fusing sensor modalities while experimenting with the effectiveness of automated target recognition algorithms in high clutter environments at high speed over off-road terrains. Work will emphasize signature management of vehicle systems and integrating the knowledge of our own susceptibility, intelligence estimates of threat capabilities, and in situ data to enhance situational awareness. Focus is also on lightweight protection systems in the area of active protection that provide hemispherical coverage while reducing the threat to dismounted forces. Last, research is being conducted on modular, scalable, integrated stand-off RF based explosive hazard (IED & Mines) detection system that can be operated as a remote or autonomous system. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: HUMAN PERFORMANCE, TRAINING & EDUCATION ***Description:*** This activity investigates two technology investment areas, warrior resilience, and decision-making and expertise development. Warrior resilience is focused on advanced training technologies and methodologies that enhance neural, cognitive, and physical readiness. Decision making and expertise development accelerates the development and improves the retention of skills in decision making, situation awareness, and individual and team adaptability and coordination on decentralized, dynamic and dispersed battlefields. Focus will be on developing component level prototypes for Marines to evaluate and experiment with. ***FY 2018 Plans:*** - Continue 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. - Continue design and development of a Marine augmented classroom environment (ACE) that will enhance instructors' teaching performance and student learning outcomes.	12.904	6.833	6.107	0.000	6.107

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue design and development of a test-bed and conduct The Basic School evaluation to test the efficacy of simulation based training in that curriculum. - Continue development and demonstrate an agent-based surrogate instructor development environment (ASIDE) to allow USMC to field small-team focused intelligent training solutions. - Continue the development of measures of training effectiveness that connect training tasks with measures of performance under various stressors. - Continue 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. - 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 2019 Base Plans:*** Rapid advances in wearable and human performance related technologies have provided the opportunity to demonstrate the utility of these technologies with Marine Corps populations to increase physical readiness and reduce injuries. The increased use of simulation-based training capabilities such as augmented reality offer the possibilities to demonstrate new capabilities, such as 3D visualization, that will accelerate and increase decision making. Efforts will support hardware, software, data collection and demonstrations to support increase decision making and expertise development and warrior resilience. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	5.051	7.829	8.460	0.000	8.460
Description: This activity investigates enhanced 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 biometric monitoring for expeditionary operations,					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
operational course of action (COA) development, and autonomous surveillance in support of distributed operations. Further, 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. ***FY 2018 Plans:*** - Continue research on the development of automated data tagging algorithms that enable connected graphs of structured and unstructured data. - Continue technology development required to enable tactical UAS on-board processing of terabytes of data in real time. - Continue research on technologies needed to tailor information delivery to warfighters based on mission context and user preferences. - Continue 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. - Continue project to develop a set of video analytic classifiers (entity, behavior, and scene) that can run in a power efficient manner in embedded hardware. - Continue 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. - Continue effort to automate the design and conduct of use cases relevant to tactical information requirements. - Continue 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. - Continue research to develop a prototype system capable of maintaining the entity models needed for entity co referencing during real time natural language processing workflows.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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. - Continue 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. - Continue 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. - Continue the development of level 1 and level 2 fusion capabilities applied to complex graphs. - Continue the development of cost functions for predictions made from data embedding spaces. -- Continue the development of a knowledge informed workflow manager capable of generating workflows automatically in response to alert conditions. - Continue the development of power efficient neuro inspired algorithms for machine understanding. - 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. - Complete project to improve expeditionary force capabilities to discover and process data across integrated cross domain systems. - 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. ***FY 2019 Base Plans:*** This activity will begin to divest investments in approximate computing for power efficiency. Research and develop prototype systems for machine question answering capabilities and in automating machine generation					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
of complex standard military information based products. Investments are also continuing in experimentation and demonstration in artificial intelligence relevant to decision support and sensor autonomy. Increased focus will be put on investments in technology to enable all sensors, weapons, platforms to be smarter and more capable of knowing why, when and how to collaborate. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: USMC FUTURE NAVAL CAPABILITIES	19.688	26.803	26.885	0.000	26.885
Description: This R-2 Activity 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 objective of the work in this PE is to develop promising technologies emerging from the FNC technology candidates funded in PE 0602131M that have been matured to higher Technology Readiness Levels (TRLs). Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0603673N. The FNC Program was restructured for FY19 to accelerate transition to the Fleet and Force. This restructuring involved a zero based review of all ongoing FNC projects, where each effort was assessed for its technology maturity and transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some efforts were terminated and others were accelerated to achieve the goals of the restructured program. Funding for FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, is being resourced in this PE. Funding for FNC technology candidates at lower TRLs (3 to 4) is being resourced in PE 0602131M. ONR is working closely with the Resource Sponsors and acquisition stakeholders to develop high priority technological capabilities needed by the operational forces. Prior to FY19, FNC Program investments were selected almost two years in advance of execution. It was determined by Navy and Marine Corps leadership that this approach limits DON's ability to exploit technology advances and respond quickly to naval needs. As a result, future BA 3 investments supporting the FNC Program are now made less than one year before commencing execution. Because FNCs are now starting at higher TRLs, the typical duration of an FNC has been shortened to 3-years. The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. Individual R-2 Activities have been discontinued and investments are organized to enhance collaboration with the acquisition stakeholders and their resource sponsors. A complete accounting of the technologies being developed and a full disposition of each					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
technology development effort referenced as continuing in the FY18 plans of this PE will be provided separately to the Congressional oversight committees. ***FY 2018 Plans:*** - Continue development of wide area surgical and persistent surveillance technologies (WASPS). - Continue Automated Processing for Spectral Exploitation and Dissemination (APSED) - Integrate and conduct laboratory tests of air-to-ground embedded processing capabilities. - Continue 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. - Continue development of spectral and reconnaissance imagery for tactical exploitation (SPRITE). - Continue Target Processing Center (TCP) Radar/Context Fusion by developing and testing algorithms to amplify or dampen threat surfaces based on Rules of Engagement (ROE). - Continue Target Processing Center (TCP) Radar Fusion and False Track Mitigation - Test and improve radar fusion and false track mitigation technologies within a relevant environment. - Continue development of the Ground Based Air Defense On-the-move high energy laser demonstrator (GBAD). - Continue Data Conditioning - Develop pattern recognition algorithms that can work against large Ground Moving Target Indicator (GMTI) data sets. - Continue 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. - Continue 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. - Continue the development of a high reliability distributed fuzing system for the 155mm DPICM projectile. - 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. ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on developing promising technologies emerging from the FNC Applied Research program that have been					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
matured to a Technology Readiness Level (TRL) of 4 to 5 in the areas of asymmetric and irregular warfare, distributed operations, information dominance, maneuverability, survivability, self-defense and expeditionary warfare. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: LOGISTICS ***Description:*** This activity investigates the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. 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. This includes efficient and responsive force sustainment, planning and directing logistics operations, logistics demand reduction, fleet maintenance, and expeditionary energy. Expeditionary Energy enhances combat capability of expeditionary warfighters by increasing the efficiency and effectiveness of energy production, storage, distribution and use. Beyond traditional energy efforts, this portfolio also looks at other issues, including energy-efficient behaviors and hybridization of energy sources. These pillars are thoroughly integrated and perpetually related in execution. ***FY 2018 Plans:*** - Continue analysis of material alternatives for automated vehicle health monitoring and reporting. - Continue demonstration of advanced concepts for mobile infrastructure. - Continue 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. - Continue integration and demonstration of advanced materials to reduce maintenance into selected vehicle and machinery components. - Continue the development of robotic systems to facilitate the packaging and handling of logistic supplies. - Continue a field demonstration of renewable energy devices and deployable equipment showing fewer liabilities when delivering expensive fuel, thereby lowering Marine Corps operational costs. - Continue operations research and analysis efforts to enhance seabased expeditionary supply chain concepts and technologies.	13.739	9.500	9.553	0.000	9.553

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue development of alternative (non-electrochemical) energy storage technologies for hybrid power system load management. - Continue development of low energy desalination technologies to allow for efficient salt-water purification at the small/ individual scale. - Continue the development of anti-fouling and non-fouling water purification components to enable enduring performance of small water purification systems. - Continue the development of real-time water quality monitoring systems for use with small scale water purification systems. - Continue the development of efficient water packaging and distribution technologies. - Initiate development of infrastructureless In-Transit Visibility (ITV) technologies to enable asset tagging, tracking, locating, and monitoring anywhere in the expeditionary supply chain. - Initiate the development of modular thermoacoustic systems capable of acting as power generation or heat-pump devices. - Initiate 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 intelligent microgrid systems for the expeditionary unit. - Complete the development of ultra-high efficiency piezoelectric devices.					
FY 2019 Base Plans: This activity has development and demonstration of advanced technologies to anticipate and reduce maintenance demands while increasing reliability. This includes advanced technology demonstrations of advanced manufacturing methods including metal additive manufacturing (AM), friction stir welding and additive friction stir welding, and cold spray for structural repair of Marine Corps equipment, creation of near net shaped parts, and advanced part demonstrations. This also includes research into the digital thread of information and cyber security required, from cradle to grave, for digital manufacturing methods, from raw materials through design, production, and qualification of parts for Marine Corps applications. This research area also includes advanced technology demonstrations that predict vehicle health and prognostics of remaining useful life for military ground vehicles and equipment in support of Condition Based Maintenance goals, while seeking to automate CBM practices through automatic data retrieval and algorithm development. The activity also will demonstrate the military utility of enhancing combat capability by increasing energy production, storage, distribution, and curbing energy consumption of the individual Marine and other tactical assets. This includes advanced system research into the scaled use of high specific power solar cell for Marine					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Corps applications ranging from the individual warfighter to augmenting the power and combat endurance unmanned robotic vehicles. Additionally investigated, system level research and demonstration of enhanced power and energy technologies to support the Marine warfighter as a system, to include enhanced power and energy storage technology, more energy efficient equipment, and enhanced power networks that enhance mission duration, decrease combat load, and enhance combat performance. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: MANEUVER ***Description:*** This activity investigates new ways and means to land forces and material through contested sea-land surface interfaces and then conduct maneuver warfare. In order to enable future Amphibious Operations, research efforts will support autonomous operations across the sea-surf-ground environment, improved fuel efficiency and speed of amphibious vehicles, amphibious vehicle technologies, water performance, and amphibious payloads to change the dynamics of a surface amphibious assault. This includes the emergence manned-unmanned teaming and autonomous vehicle collaboration. The technologies included in this work address areas of mobility, materials, propulsion, signature reduction, modularity, and unmanned systems. ***FY 2018 Plans:*** - Continue development of fuel efficiency and battlefield power systems for improved performance. - Continue survivability improvements and technologies to mitigate acceleration and traumatic brain injuries to occupants to enhance tactical mobility and survivability. - Continue 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. - Continue 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.	14.241	13.598	13.467	0.000	13.467

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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). - Continue efforts to demonstrate integrated armor solutions that provide lighter weight armor materials with - Continue the development of autonomy technologies and system concepts that will enable unmanned ground vehicles (UGVs) to be used as autonomous logistic connector vehicles. - Continue the development of fuel saving vehicle technologies, including advanced transmission, power train, and electrical power system technologies. - Continue mobility technologies that enable improved vehicle/warfighter agility and stability. - Continue lightweight armor, material, and structural technologies that enable maneuver and survivability of small, light expeditionary platforms. - Continue survivability technologies that enable defeat of all unitary and tandem RPG and select ATGM threats, and the demonstration of survivable vehicles. - Continue the development of technologies that enable vehicle component modularity and reduce life cycle costs. - Continue development of a Combat S&T Vehicle demonstrator to enhance crew survivability and vehicle fuel efficiency. - Continue 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. - Continue 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. - Continue the development of autonomous perception technologies to enable operations under adverse atmospheric conditions. - 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 development of a vehicle demonstrator that focuses on enhanced crew survivability.					
FY 2019 Base Plans: This activity will develop and evaluate mobility technologies and future concepts for the ground and amphibious fleet to improve maneuverability across a range of challenging terrain environments. Work will emphasize					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
experimentation with autonomy approaches through both simulation and live events for amphibious vehicles from small low cost craft, traditional amphibious combat and assault vehicles, and landing craft. Additional focus will be on integrating real time precepts with learned information, a priori knowledge, and contextual understanding to facilitate informed autonomous decision making. There will be demonstration and experimentation with systems that enable intelligent planning, reasoning, learning, and control to affect tactically appropriate autonomous behaviors in littoral and urban environments. In addition efforts will be pursued in component technology and prototypes for future advanced manned expeditionary ground vehicles and amphibians. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: EXPEDITIONARY CYBER ***Description:*** This activity provides 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, limited 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. ***FY 2018 Plans:*** - Initiate a USMC Expeditionary Cyber Advanced Technology Activity addressing Cyber at the Tactical edge. - Initiate RF-enabled cyber payloads. - Initiate low SWAP distributed precision time transfer. - Initiate cognitive authentication. ***FY 2019 Base Plans:*** The Expeditionary Cyber portfolio focuses heavily on the development and integration of multiple underlying technologies into subsystems and system demonstrations supporting experimentation. The Expeditionary Cyber	0.000	4.000	4.475	0.000	4.475

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
portfolio is also closely coordinated with the C4 research portfolio also described herein to efficiently exploit co-design opportunities and shorten development times needed to keep pace in an environment rapidly driven by Moore's Law. Battle damage assessment technologies are integrated into system sensor technologies to prove efficacy in an increased TRL application in cyber experimentation. Cyber experimentation will be performed on an autonomous system operating in a test range. Novel resilient cyber components and architectures integrated into a multi-function cyber-EW system will be demonstrated in a realistic electro-magnetic (EM) environment measuring performance. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY2018 to FY2019 is due to increase investment in autonomous cyber experimentation.					
Accomplishments/Planned Programs Subtotals	91.213	94.664	103.176	0.000	103.176

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.

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COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2297: *Futures Directorate*	0.000	45.977	59.743	47.069	-	47.069	47.991	47.965	48.913	49.909	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.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: COMBAT SERVICE SUPPORT (CSS) AND FORCE PROTECTION	8.658	18.206	8.142	0.000	8.142
Description: This activity includes MCWL/FD CSS and force protection experimentation efforts including assessment of equipment, new TTPs, training programs, and proposed organizational changes associated with enhanced capabilities. This area provides seabasing, expeditionary logistics, urban combat, and expeditionary medicine experimentation support. 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. ***FY 2018 Plans:*** - Continue assessment of unmanned ground logistics delivery technologies that support infantry small unit operations. - Continue testing and assessment of logistics enablers in support of EF21 experimentation. - Continue 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. - Continue evaluation and assessment of emerging technologies that support energy demand reduction.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue 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. - Continue evaluation and experimentation with technologies that can identify, neutralize, or destroy unmanned systems (aerial, ground, or surface). - Continue assessment and experimentation to understand the relevance of autonomy to ship to shore surface connectors. - Continue assessments and experimentation with advanced technologies to enable standoff detection of IEDs. - Continue development and assessment of enhanced seabased medical capabilities in support of the MAGTF. - 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 2019 Base Plans: Continue to develop prototypes and experiment with logistics enablers in support of dismounted operations and the EF-21 concept. This includes completing assessment and experimentation to understand the relevance of autonomy to ship to shore surface connectors to focus on development and experimentation with afloat and forward-deployed metal adaptive manufacturing. Continue to explore technologies and methodologies that reduce resource consumption and enhance sustainability of the distributed units. Pursue investigations and experimentation with independent, conditioned, reliable power sources to dismounted and/or distributed forces operating in austere conditions. Wrap-up assessments and experimentation in order to provide logistics common operational picture for commanders and logistics planners across the area of operations. Continue to develop and study technologies that enhance unit survivability; to include various aspects of critical care and medical related protocols and processes.					
FY 2019 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY 2018 to FY 2019 is mainly attributable to an FY 2018 $10M investment to support integration and experimentation with a Defense Advanced Research Projects Agency (DARPA)-initiated Vertical Take-Off and Landing (VTOL) developed technology prototype for a full scale, modular multi-mission unmanned air system (UAS). Funding completes experimental prototype development, flight testing, and validation of operating characteristics.					
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 TTPs, training programs, and proposed organizational changes associated with enhanced C4 capabilities. The area provides cutting edge/enhanced over-the-horizon (OTH), beyond line of sight (BLOS), satellite and non-satellite based C4 capabilities to support experimentation. 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. ***FY 2018 Plans:*** - Continue development and assessment of systems that permit unmanned aerial system (UAS) operations in a global positioning system (GPS) denied environment. - Continue development and assessment of a configurable C2 suite that enhances operations from aviation platforms in support of EF21 experimentation. - Continue 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. - Continue evaluation and experimentation with emerging technologies that support future maritime C2 capabilities/EF21. - Continue assessment and experimentation with integration and interoperability of software applications to increase the situational awareness, lethality, and survivability of distributed tactical ground formations. - Complete development and assessment of a MAGTF network management system. - Continue 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.	8.931	10.525	8.614	0.000	8.614

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue development and experimentation that enable seamless operations in a technology denied environment. - Complete development and assessment of a configurable C2 suite that enhances operations from aviation platforms in support of Expeditionary Force 21 (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 2019 Base Plans:*** Continue to identify and assess a collaborative solution that provides tailorable OTH, OTM communications, situational awareness, and fires for the forward deployed MAGTF to include Digital Integration (DI). Experiment with a BLOS, OTH, OTM voice, data, and position location information network in an EF-21 environment. Conclude development and assessment of systems that permit UAS operations in a GPS denied environment. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY2018 to FY2019 is the result of the completion of selected efforts related to the development and assessment of a configurable C2 suite that enhances operations from aviation platforms in support of EF21 experimentation.					
Title: FIRES, TARGETING, AND MANEUVER	8.193	6.114	6.029	0.000	6.029
Description: This activity includes MCWL/FD experimentation efforts in the areas of fires, targeting, and maneuver including assessment of equipment, new TTPs, training programs, and proposed organizational changes associated with enhanced capabilities. This area increases FTM related troop environmental awareness, lethality, and mobility using fused sensors as well as unmanned weaponized and reconnaissance air and ground vehicle platforms to support experimentation. 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
$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. ***FY 2018 Plans:*** - Continue development and assessment of weaponized unmanned ground robotic systems. - Continue development of technologies that enhance the utility of autonomous systems. - Continue research, development, and experimentation with weapons and other ground combat systems that enhance the combat effectiveness of small units operating in the urban littorals. - Continue investigation of innovative technologies to enhance squad-level capabilities. - Continue assessment and experimentation into the utility of robotic systems as platforms to support target acquisition and designation. - Continue assessment of the expeditionary utility of autonomous swarming technologies for unmanned air and ground systems. - 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 2019 Base Plans:*** Continue to develop technologies, demonstrate, and experiment with robotic systems organic to an infantry company for intelligence collection, indirect fires, direct fires and breaching capabilities. Complete assessment of the expeditionary utility of autonomous swarming technologies for unmanned air and ground systems. Pursue company level precision guided munitions. Initiate efforts to provide a missile system with a real-time wireless data link to provide lethal beyond line of sight fires (sea-land and land-land) against static and moving targets in the urban littoral environment. Automate robotic control systems/software to reduce the burden of control and increase manned and unmanned teaming. Initiate and complete investigations into battery configuration and ruggedization as well as associated battery-driven gearbox of an amphibious electric all-terrain vehicle. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant difference between FY18 and FY19.					
Title: MARINE AIR-GROUND TASK FORCE (MAGTF) INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	2.887	6.414	4.376	0.000	4.376

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Description: This activity includes MCWL/FD ISR related experimentation efforts including assessment of equipment, new TTPs, training programs, and proposed organizational changes associated with enhanced ISR capabilities. Using a variety of fused sensors to mesh data, video, and images and incorporating a common tactical controller to operate multiple air and ground ISR platforms, this area enhances small unit situational awareness as well as exploitation and forward engagement ability via experimentation. 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. ***FY 2018 Plans:*** - Continue development and assessment of seabased and landing force ISR capabilities that enable EF21 experimentation. - Continue development, integration, and assessment of technologies to fuse multiple sensor payloads into a single user interface to enable utility for tactical operators. - Continue examination and assessment of technologies that support future employment of UAS operations from seabased platforms. - Continue assessment and experimentation with integration and interoperability of software applications to increase the situational awareness, lethality, and survivability of distributed tactical ground formations. - 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 2019 Base Plans:*** Continue to increase situational awareness of battlespace in order to defend against and repel enemy attacks in those domains at the company and lower echelons. Assess systems to combine sensor and telemetry data from multiple unmanned platforms (ground, surface (water), and air) in order to provide a more relevant and usable					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
tactical picture. Initiate efforts to provide a small, lightweight, semi-autonomous system that can self-navigate structure interiors while simultaneously visibly inspecting and creating real-time three-dimensional (3D) maps. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY2018 to FY2019 is due to a reduced investment in investigating, developing and/or assessing technologies that: automate UAS management efforts and narrowing focus on efforts that seek to enhance sensor payload management (focusing on commercial off-the-shelf small UASs).					
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. This area provides overarching experimentation doctrine, planning, management, technical/engineering support, analysis, data collection, and reporting. Programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. ***FY 2018 Plans:*** - Continue to synthesize results and lessons learned into proposed DOTMLPF recommendations for the Marine Corps. - Continue to provide technical, strategic, and managerial support to Marine Corps experimentation. - Continue to provide overall analysis and reporting of experimentation efforts, analytical assistance during experiment design, and maintenance of an ad-hoc analysis capability. - Continue deliberate broad-based commercial technology forecasting in support of experimentation long-range planning and combat development. - Continue technical, strategic, and managerial support for operations with advanced technology utilizing autonomy, robotics, and cyber capabilities. ***FY 2019 Base Plans:*** Continue to provide encompassing experimentation doctrine, planning, analysis, and data collection in order to conduct relevant enactments and report on experimentation results. Look to the future and identify up	12.298	12.418	12.659	0.000	12.659

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
and coming (cutting edge) technology areas of interest. Provide generalized as well as specific program engineering, technical, and management support. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant difference between FY18 and FY19.					
Title: WARFIGHTING EXCELLENCE ***Description:*** This activity includes 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. ***FY 2018 Plans:*** - 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 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.	5.010	6.066	7.249	0.000	7.249

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. - Complete development and assessment of modeling and simulation hardware, software, and training capabilities that support planning/experimentation processes.					
FY 2019 Base Plans: Continue to support the combat development process by helping to develop and refine emerging concepts, conceptualize force design, and identify future capabilities and deficiencies within future operating environments. This is accomplished by means of enhancing current functional capabilities by investigations into Next Generation Wargaming tools as well as conducting extensive wargaming as an augmentation to live force experimentation. Efforts include 11 planned wargames (4 large, 5 medium, and 2 small) with areas of interest covering EF21 related concepts. Focusing 15 to 30 years in the future, continue to offer top level identification and analysis of emerging asymmetric threats and opportunities. This is accomplished by capitalizing on a myriad of foresight assessments of future operating environments. Continue to develop, assess, and provide insight into joint efforts and warfighting concepts. Specific areas of investment include: 1) Demonstrating the military utility of a resilient, low-cost, effective, high-altitude balloon-borne communications platform that can be rapidly deployed to enhance warfighter communication capabilities and 2) Informing the development of distributed mobile amphibious (and ground) assault fuel logistics capabilities as well as demonstrating the feasibility of executing the concept in support of a "fight tonight" scenario using current fleet assets, by adapting current naval practices. Initiate investigations into candidate technologies that support urban operations, in an effort to identify/eliminate capability gaps and develop TTPs to include subterranean maneuver. This is an attempt to: 1) Develop a 5th generation force capable of ship to shore movement against a peer adversary, enabling distributed maneuver at varied distances and 2) Develop a 6th generation force capable of dominating the urban environment. The concepts: 1) Explore innovative delivery systems to augment current ability to maneuver troops, effects, and materiel from ship to shore in contested environments and 2) Involve integration by engineers and scientists with planners and operators to identify key capability concept areas for development.					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The funding increase from FY2018 to FY2019 is due to investigations which focus on operating in urban environments.					
Accomplishments/Planned Programs Subtotals	45.977	59.743	47.069	0.000	47.069

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, 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: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	12.790	13.448	13.313	-	13.313	13.307	13.301	13.564	13.840	Continuing	Continuing
3022: *Joint Non Lethal Weapons*	0.000	12.790	13.448	13.313	-	13.313	13.307	13.301	13.564	13.840	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: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	13.117	13.448	13.387	-	13.387
Current President's Budget	12.790	13.448	13.313	-	13.313
Total Adjustments	-0.327	0.000	-0.074	-	-0.074
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.319	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.074	-	-0.074
• Congressional General Reductions Adjustments	-0.008	-	-	-	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
3022: *Joint Non Lethal Weapons*	0.000	12.790	13.448	13.313	-	13.313	13.307	13.301	13.564	13.840	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: JOINT NON-LETHAL WEAPONS	12.790	13.448	13.313	0.000	13.313
FY 2018 Plans: - 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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continued development of technologies to deliver emerging novel counter-materiel and counter-personnel payloads to target while minimizing risk to the operator. - Continued 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. ***FY 2019 Base Plans:*** Continue the development, integration, and demonstration of advanced technologies and payloads capable of addressing non-lethal counter-personnel and counter-material capability gaps while minimizing risk to the operator. Development efforts include the prototyping of advanced payloads, delivery systems, alternative technologies, and high power microwave component hardware and modular systems for non-lethal vehicle and vessel stopping applications. Development and integration of advanced millimeter wave component technologies for counter-personnel directed energy effects will continue in order to reduce system size, increase energy efficiency, and improve performance. Human effects modeling and analysis efforts will incorporate knowledge gained from applied research studies into a suite of programs and surrogates that enable assessment and prediction of injury risk and effectiveness for NLW stimuli. Transition prototype technologies offering operational utility to higher levels of technology development and acquisition. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	12.790	13.448	13.313	0.000	13.313

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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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 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: PB 2019 Navy	Date: February 2018
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603671N *I (U)Navy Advanced Technology Development(ATD)*

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	0.000	131.502	-	131.502	171.675	181.216	160.056	163.309	Continuing	Continuing
3433: *Navy Advanced Technology Development (ATD)*	0.000	0.000	0.000	131.502	-	131.502	171.675	181.216	160.056	163.309	Continuing	Continuing

Note

Program Element (PE) 0603671N Navy Advanced Technology Development (ATD) is created in FY2019 to realign and consolidate Navy Advanced Technology Development efforts previously identified and justified in PEs 0603758N Navy Warfighting Experimentation and Demonstration, 0603782N Mine and Expeditionary Warfare Advanced Technology Dev., 0603729N Warfighter Protection Advanced Technology, 0603271N Electromagnetic Systems Advanced Technology, and 0603123N Force Protection Advanced Technology. These effort include Mine Technology; Joint EOD Demos; Naval Warfare Experimentation; Operations Analysis; SwampWorks; Tech Solutions; Noise Induced Hearing Loss (NIHL); Aircraft Technology; Electronic and Electromagnetic Systems Technology; Global Positioning System (GPS) and Navigation Technology; and Surface Ship and Submarine Hull Mechanical and Electrical Advanced Technology Development research efforts.

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the Naval Research and Development Framework in order to quickly advance new capabilities from discovery to deployment across the warfighting domains. The portfolio of technologies advanced in the PE span the full breadth of research supporting the Navy and Marine Corp mission.

Technology development activities include projects and programs to support numerous high priority Advanced Technology Development opportunities and Navy and Marine Corp needs. These efforts include research supporting on-demand battlespace shaping through advanced undersea weapons; technologies to support a standoff or remote capability for detection and location, diagnosis, render safe, neutralization and enhanced access; efforts that seek to capitalize on recent technology breakthroughs to develop and integrate components including subsystems into prototypes quickly: efforts 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; exploration of high-risk, disruptive, and innovative technologies and concepts to provide a venue to develop innovative technologies that are targeted towards advancing the capabilities of naval warfighters; investments that provide rapid response Science and Technology (S&T) solutions to immediate Fleet/Force needs identified by individual warfighters at the deckplate level; specific electronic and electromagnetic systems research to improve weapons systems and data fusion technology; research to reduce and eliminate the incidence of noise reduced hearing loss; 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; programs to develop, test, and demonstrate advanced communications, electronic attack (EA), electronic surveillance (ES), electronic warfare (EW), and radar functions; develop and demonstrate 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; efforts that support the development of technologies associated with various naval platforms (surface, subsurface and terrestrial) and the protection of those platforms; and protect the rights, safety, and welfare of human subjects in research supported by the Navy and Marine Corps.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603671N *I (U)Navy Advanced Technology Development(ATD)*

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	131.502	-	131.502
Total Adjustments	0.000	0.000	131.502	-	131.502
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	131.895	-	131.895
• Rate/Misc Adjustments	0.000	0.000	-0.393	-	-0.393

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	Project (Number/Name) 3433 / *Navy Advanced Technology Development (ATD)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
3433: *Navy Advanced Technology Development (ATD)*	0.000	0.000	0.000	131.502	-	131.502	171.675	181.216	160.056	163.309	Continuing	Continuing

Note

Project 3433 in PE 0603671N Navy Advanced Technology Development (ATD) is created in FY2019 to realign and consolidate Navy Advanced Technology Development efforts previously identified and justified in PEs Navy Warfighting Experimentation and Demonstration, 0603782N Mine and Expeditionary Warfare Advanced Technology Dev., 0603729N Warfighter Protection Advanced Technology, 0603271N Electromagnetic Systems Advanced Technology, and 0603123N Force Protection Advanced Technology. These effort include Mine Technology; Joint EOD Demos; Naval Warfare Experimentation; Operations Analysis; SwampWorks; Tech Solutions; Noise Induced Hearing Loss (NIHL); Aircraft Technology; Electronic and Electromagnetic Systems Technology; Global Positioning System (GPS) and Navigation Technology; and Surface Ship and Submarine Hull Mechanical and Electrical Advanced Technology Development research efforts.

A. Mission Description and Budget Item Justification

The activities described in this project address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains. The portfolio of technologies advanced in the PE span the full breadth of research supporting the Navy and Marine Corp mission.

Technology development activities include projects and programs to support numerous high priority Advanced Technology Development opportunities and Navy and Marine Corp needs. These efforts include research supporting on-demand battlespace shaping through advanced undersea weapons; technologies to support a standoff or remote capability for detection and location, diagnosis, render safe, neutralization and enhanced access; efforts that seek to capitalize on recent technology breakthroughs to develop and integrate components including subsystems into prototypes quickly: efforts 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; exploration of high-risk, disruptive, and innovative technologies and concepts to provide a venue to develop innovative technologies that are targeted towards advancing the capabilities of naval warfighters; investments that provide rapid response Science and Technology (S&T) solutions to immediate Fleet/Force needs identified by individual warfighters at the deckplate level; specific electronic and electromagnetic systems research to improve weapons systems and data fusion technology; research to reduce and eliminate the incidence of noise reduced hearing loss; 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; programs to develop, test, and demonstrate advanced communications, electronic attack (EA), electronic surveillance (ES), electronic warfare (EW), and radar functions; develop and demonstrate 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; efforts that support the development of technologies associated with various naval platforms (surface, subsurface and terrestrial) and the protection of those platforms; and protect the rights, safety, and welfare of human subjects in research supported by the Navy and Marine Corps.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Mine Technology	0.000	0.000	11.188	0.000	11.188
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. ***FY 2018 Plans:*** N/A ***FY 2019 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 thrust include prototyping advanced sensors and sensor configuration technologies for improved discrimination as well as communications, command, and control technologies. Initiate prototyping and demonstration for next-generation target detection devices. Funding supports JEON PC-0012 Advanced Maritime Mining Capability. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Mine Technology from PE 0603782N Mine and Expeditionary Warfare Advanced Technology.					
Title: Joint EOD Demos	0.000	0.000	1.984	0.000	1.984
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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. 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 2018 Plans:*** N/A ***FY 2019 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 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. Initiate development and demonstration of technologies for low-observability underwater ordnance neutralization. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Joint EOD Demos from PE 0603782N Mine and Expeditionary Warfare Advanced Technology.					
Title: Naval Warfare Experimentation ***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.	0.000	0.000	20.602	0.000	20.602

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 Plans: N/A ***FY 2019 Base Plans:*** Continue efforts from FY18 that were in progress within PE 0603758N Navy Warfare Experimentation and initiate new efforts to address the priorities of the Chief of Naval Research and the Chief of Naval Operations. Efforts will be conducted within areas such as Augmented Warfighter, Integrated & Distributed Forces, Operational Endurance, Sensing & Sense-Making, and Scalable Lethality. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Navy Warfare Experimentation from PE 0603758N Navy Warfighting Experimentation and Demonstration, and increased investment in Augmented Warfighter, Integrated & Distributed Forces, Operational Endurance, Sensing & Sense Making, and Scalable Lethality due to CNO direction to increase participation in Fleet Experimentation events.					
Title: Operations Analysis ***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 war gaming, and the development of innovation strategies and messages resulting from these analyses. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Conduct war games, Technology Innovation Games and technology analysis efforts to inform ONR S&T initiatives in such areas as Augmented Warfighter, Integrated & Distributed Forces, Operational Endurance, Sensing & Sense-Making, and Scalable Lethality. ***FY 2019 OCO Plans:***	0.000	0.000	2.216	0.000	2.216

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Operations Analysis from PE 0603758N Navy Warfighting Experimentation and Demonstration.					
Title: SwampWorks ***Description:*** The objective of this portfolio is to explore high-risk, disruptive, and innovative technologies and concepts, and provide a venue to develop innovative technologies that 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 program has substantial flexibility in planning and execution which includes a streamlined approval process allowing for the shortest possible technology development timeframe. The portfolio is not limited to any set of technology areas with innovative technology development ultimately providing a dramatic improvement for the warfighter. 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 that transitions into the Acquisition Program of Record (POR). ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Continue 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). 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. While the portfolio is open to a wide variety of technology areas, some focus is applied to areas such as initiatives in such areas as Augmented Warfighter, Integrated & Distributed Forces, Operational Endurance, Sensing & Sense-Making, and Scalable Lethality. The balance of the S&T projects that will start in FY19 will be identified during FY19 as the needs of the warfighters, for investments in this portfolio, evolve or change. ***FY 2019 OCO Plans:***	0.000	0.000	22.383	0.000	22.383

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for SwampWorks from PE 0603758N Navy Warfighting Experimentation and Demonstration					
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 from such requests and are completed in approximately twelve to eighteen months, concluding with a prototype demonstration. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** This program will conduct new S&T developments based on Fleet/Force interactions and expressed warfighter needs. The program will be readily available to support the mission of the fleet by responding to Sailors/Marines need for technology. Developments will be undertaken to deliver rapid response solutions so warfighters can achieve mission success and perform their duties better, faster, or easier by leveraging technology that has recently been developed or is emergent. Demonstrations will be conducted with warfighters at the conclusion of developments to assess the utility of the technology and understand what steps remain to achieve transition. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Tech Solutions from PE 0603758N Navy Warfighting Experimentation and Demonstration.	0.000	0.000	10.184	0.000	10.184
Title: Special Projects ***Description:*** The efforts described in this Activity are based on investment directions as defined in the Naval Research and Development Framework. 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).	0.000	0.000	12.445	0.000	12.445

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. Efforts in this area support Naval Precision Strike Operations, providing the Navy capability to quickly locate, target, and strike critical targets. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Conduct 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. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Special Projects from PE 603758N Navy Warfighting Experimentation and Demonstration					
Title: Noise Induced Hearing Loss (NIHL) ***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 2018 Plans:*** N/A ***FY 2019 Base Plans:*** 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. ***FY 2019 OCO Plans:***	0.000	0.000	4.877	0.000	4.877

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Noise Induced Hearing Loss (NIHL) from PE 0603729N Warfighter Protection Advanced Technology.					
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 Research and Development Framework, principally in the Autonomy and Unmanned Systems, Platform Design and Survivability, Power and Energy and Total Ownership Cost Focus Areas. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Conduct 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Aircraft Technology from PE 0603123N Force Protection Advanced Technology	0.000	0.000	6.251	0.000	6.251
Title: Electronic and Electromagnetic Systems ***Description:*** The overarching objective of the Electronic and Electromagnetic Systems Activity is to develop, test, and demonstrate Communications, Electronic Attack (EA), Electronic Surveillance (ES), Electronic Warfare	0.000	0.000	4.204	0.000	4.204

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
(EW), and Radar functions. 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 planned for transition at the end of their schedule into the associated acquisition program of record. Major thrust within the Electronics and Electromagnetic Systems program are: a) Advanced EW Enabling Technologies - Develop classified advanced electronic warfare technology in support of current and predicted capability requirements; and 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 Integrated Topside (InTop) program to optimize spectrum and functional use across a platform and an entire battle group. ***FY 2018 Plans:*** N/A ***FY 2019 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 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Electronic and Electromagnetic Systems from PE 0603271N Electromagnetic Systems Advanced Technology					
Title: Global Positioning System (GPS) & NavigationTechnology ***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.	0.000	0.000	4.600	0.000	4.600

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Naval units. 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 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 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Conduct 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 that enables robust integrity checking and monitoring of GPS 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; atomic clocks that possess unique long-term stability and precision for the purpose of providing GPS-independent precision time as well as time-transfer techniques 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, correlation navigation technique using high precision earth maps, for those Naval platforms which may not have GPS navigation capabilities and/or loss of GPS signals. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Global Positioning System (GPS) & Navigation Technology from PE 0603271N Electromagnetic Systems Advanced Technology					
Title: Human Research Protection Program (HRPP)	0.000	0.000	2.685	0.000	2.685
Description: The purpose of Department of the Navy (DON) Human Research Protection Program (HRPP) is to protect the rights, safety, and welfare of human subjects in research supported by the Navy and Marine Corps. The Office of Naval Research (ONR) Research Protections Division, a component of the DON HRPP, is responsible for: 1) ensuring that research involving human subjects complies with Federal, DoD, and DON research protection requirements; and 2) providing education programs in human research ethics to all levels					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
of staff involved in the review, approval, conduct, management, or support of DON research involving human subjects. The Secretary of the Navy Instruction (SECNAVINST) 3900.39D identifies the Navy Surgeon General (SG) as the single point of accountability for the DON-wide program and identifies the Chief of Naval Research (CNR) as providing support and expertise for human research protection in the systems commands, operational forces, training commands and DON-supported non-DoD institutions. The program is essential to enabling DON to satisfy mandated DoD Instruction 3216.02 requirements. ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** Execute DON HRPP Management Plan; provide day-to-day oversight of DON HRPP activities; conduct periodic site inspections and assist visits; conduct Component-level review of DON-supported human subjects research; provide subject matter expertise and guidance on all DON-supported research involving human subjects; implement revisions to SECNAVINST 3900.39D; and provide DON input to ASD(R&E) and other DoD policy guidance impacting DON human research-related efforts. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase in FY19 reflects the realignment of funding for the Human Research Protection Program (HRPP) from Operation and Maintenance, Navy (O&M,N) BA 3 Administration (4A1M) for proper alignment of funding.					
Title: Surface Ship and Submarine Hull Mechanical & Electrical ***Description:*** 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 various naval platforms (surface, subsurface and terrestrial) and the protection of those platforms. The primary research efforts within this activity are focused on advanced technology demonstrations to evaluate emerging energy technologies, advanced technology development for Unmanned Sea Surface Vehicles in support of Naval S&T Focus Area on Autonomy and Unmanned Vehicles and At-Sea Vertical Launch	0.000	0.000	27.883	0.000	27.883

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
System rearming. Unmanned Sea Surface Vehicle (USSV) technology development includes autonomous navigation for USSVs. ***FY 2018 Plans:*** N/A ***FY 2019 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 innovative energy technologies using Navy and Marine Corps facilities as test beds. Perform non-recurring engineering, modeling and fabrication necessary for a prototype and demonstration of At-Sea Rearm of Vertical Launch System (VLS) capability in a relevant environment during FY22. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding increase from FY18 to FY19 reflects the realignment of funding for Surface Ship & Submarine Hull Mechanical & Electrical (HM&E) from PE 0603123N Force Protection Advanced Technology. Additionally, funds are increased in FY 2019 for engineering and prototype development cost associated with the scheduled demonstration of the Vertical Launch System (VLS) Reload at Sea effort.					
Accomplishments/Planned Programs Subtotals	0.000	0.000	131.502	0.000	131.502

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603671N / *(U)Navy Advanced Technology Development(ATD)*	**Project (Number/Name)** 3433 / *Navy Advanced Technology Development (ATD)*

this PE is reviewed at several levels to ensure that the investment is relevant and productive. At the macroscopic level, investments are often coordinated with a variety of organizations, examples of which include the Navy Warfare Development Command, Commander, Fleet Forces Command, resource sponsors, program offices, etc. to address the goals, objectives and needs identified by the warfighters. 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 Limited Objective Experiments 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	254.203	231.772	232.996	-	232.996	230.269	249.478	269.260	274.734	Continuing	Continuing
3346: *Future Naval Capabilities Adv Tech Dev*	0.000	237.761	231.772	232.996	-	232.996	230.269	249.478	269.260	274.734	Continuing	Continuing
9999: *Congressional Adds*	0.000	16.442	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	16.442

A. Mission Description and Budget Item Justification

The FNC program represents the requirements-driven, delivery-oriented piece of the DON S&T portfolio. The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Future Naval Capabilities (FNC) Program. The objective of the work in this PE is to develop promising technologies emerging from the FNC Applied Research program funded in PE 0602750N Future Naval Capabilities Applied Research that have been matured to higher Technology Readiness Levels (TRLs). The FNC Program was restructured for FY19 to accelerate transition to the Fleet and Force. This restructuring involved a zero based review of all ongoing FNC projects, where each effort was assessed for its technology maturity and transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some efforts were terminated and others were accelerated to achieve the goals of the restructured program. Funding for FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, is being resourced in this PE. Funding for technology candidates at lower TRLs (3 to 4) is being resourced in PE 0602750N Future Naval Capabilities Applied Research . ONR is working closely with the Resource Sponsors and acquisition stakeholders to develop high priority technological capabilities needed by the operational forces.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	249.092	231.772	233.894	-	233.894
Current President's Budget	254.203	231.772	232.996	-	232.996
Total Adjustments	5.111	0.000	-0.898	-	-0.898
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-6.711	0.000			
• SBIR/STTR Transfer	-5.105	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.898	-	-0.898
• Congressional General Reductions Adjustments	-0.073	-	-	-	-
• Congressional Add Adjustments	17.000	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *ASW Research Prog - Cong*	6.770	0.000
Congressional Add: *Program Increase*	9.672	0.000
Congressional Add Subtotals for Project: 9999	16.442	0.000
Congressional Add Totals for all Projects	16.442	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.202 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
3346: *Future Naval Capabilities Adv Tech Dev*	0.000	237.761	231.772	232.996	-	232.996	230.269	249.478	269.260	274.734	Continuing	Continuing

A. Mission Description and Budget Item Justification

Prior to FY19, FNC Program investments were selected almost two years in advance of execution. It was determined by Navy and Marine Corps leadership that this approach limits DON's ability to exploit technology advances and respond quickly to naval needs. As a result, future BA 3 investments supporting the FNC Program are now made less than one year before commencing execution. Because FNCs are now starting at higher TRLs, the typical duration of an FNC has been shortened to 3-years. The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. R-2 Activities were modified for FY19 to align to warfare areas and the corresponding resource sponsors that will integrate FNC technologies into acquisition programs of record. A complete accounting of the technologies being developed and a full disposition of each technology development effort referenced as continuing in the FY18 plans of this PE will be provided separately to the Congressional oversight committees.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: CAPABLE MANPOWER (CMP)	18.322	19.541	7.723	0.000	7.723
Description: The Capable Manpower R-2 Activity, modified for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N Future Naval Capabilities Applied Research . These advanced technology investments align to acquisition programs of record principally under the purview of Deputy CNO for Manpower, Personnel, Training and Education and Marine Corps Training and Education Command (TECOM). ***FY 2018 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) - 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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) - 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)					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on the future integrated training environment for integrated air and ground operations of the marine air-ground task force, learning continuum and performance aids, manpower, personnel and training strategic planning, simulation tailored training and assessments, decision making and learning management systems, an assessment process for the selection of unmanned aerial systems personnel, simulation toolsets for analysis of mission, personnel and systems that includes techniques to optimize manpower planning, next generation perceptual training systems and tools, augmented immersive team training, behavioral and performance analysis for intelligent training, advanced technologies for automated performance assessment in games and tools for game-based training and assessment of human performance. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease for this R-2 Activity is due to the modifications that were made to the overall FNC Program R-2 Activity Structure, which moved some investments previously aligned to this R-2 Activity to the					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Information Warfare, Surface Warfare and Undersea Warfare R-2 Activities as noted in the FY18 Plans section below.					
Title: ENTERPRISE AND PLATFORM ENABLERS (EPE)	18.306	14.559	0.000	0.000	0.000
Description: The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. 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)					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: EXPEDITIONARY MANEUVER WARFARE (EMW) ***Description:*** The Expeditionary Maneuver Warfare R-2 Activity, modified for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to acquisition programs of record principally under the purview of the Deputy Commandant for Combat Development and Integration (CD&I) and the Director of Expeditionary Warfare (OPNAV N95). ***FY 2018 Plans:*** FNC: EMW-FY17-01 HIGH RELIABILITY DPICM REPLACEMENT (HRDR) - Continued High Reliability DPICM Replacement in PE 0603640M. ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on autonomous unmanned surface vehicles for mine warfare, off-board refueling and data transfer for unmanned surface vehicles, automated data analysis for expeditionary mine-countermeasures, advanced undersea weapon systems for mine warfare, ground based air defense on-the-move high energy laser	2.920	0.000	10.551	0.000	10.551

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
systems, advanced sonar technology for high clearance rate mine countermeasures, defense of harbor and near-shore naval infrastructure against asymmetric threats, fuel efficient tactical vehicles, renewable and sustainable expeditionary power, exchange of actionable information at the tactical edge, actionable intelligence enabled by persistent surveillance, densified propellants for fire from enclosed/confined spaces, spectral and reconnaissance imagery, azimuth and inertial navigation systems, counter radio-controlled improvised explosive device electronic warfare, and precision universal mortars. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 for this R-2 Activity is due to the modifications that were made to the overall FNC Program R-2 Activity Structure, which moved some investments previously aligned to the Sea Shield FY18 R-2 Activity into this R-2 Activity as noted in the FY18 Plans section of the Sea Shield R-2 Activity.					
Title: FORCE HEALTH PROTECTION (FHP)	14.364	10.910	0.802	0.000	0.802
Description: The Force Health Protection R-2 Activity focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to programs under the purview of the Surgeon General of the Navy (OPNAV N093) and the Defense Health Agency. ***FY 2018 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)					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on enabling new practices, procedures, medical devices and pharmaceuticals for the improvement of personnel performance, casualty prevention and combat casualty care. These technologies aim to decrease the logistical burden of forward medical operations, mitigate and prevent combat-related illness and injury, and provide cutting-edge medical applications for Navy and Marine Corps warfighters on land, at sea and in the air. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease in this R-2 Activity is due to the completion in FY18 of FHP-FY14-01 Acute Care Cover for Severely Injured Limbs (ACCSIL) and FHP-FY14-03 Blast Load Assessment Sense and Test (BLAST).					
Title: FORCENET (FNT) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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	56.919	61.657	0.000	0.000	0.000

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

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

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: POWER AND ENERGY (P&E) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. 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)	15.884	15.817	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue Torpedo Advanced Propulsion System (TAPS) - Conduct limited component development and testing, preparing for a down-selection to one technology. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SEA SHIELD (SHD) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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. (In FY19, this FNC Product will be realigned within this PE to SW-FY13-02 under a new Surface Warfare R-2 Activity) 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)	65.738	59.974	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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). (In FY19, this FNC Product will be realigned within this PE to EMW-FY14-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - 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). (In FY19, this FNC Product will be realigned within this PE to EMW-FY14-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) - 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). (In FY19, this FNC Product will be realigned within this PE to EMW-FY14-03 under a new Naval Expeditionary Maneuver Warfare R-2 Activity) 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. FNC: SHD-FY16-04 SHIP-LAUNCHED EW EXTENDED ENDURANCE DECOY (SEWEED)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- 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. (In FY19, this FNC Product will be realigned within this PE to SW-FY16-01 under a new Surface Warfare R-2 Activity) 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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SEA STRIKE (STK) ***Description:*** The investments that would have continued in this R-2 Activity have been moved into the activities of the restructed FNC Program. ***FY 2018 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.	45.308	49.314	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FNC: STK-FY13-04 AIM-9X ENABLERS (AXE) - 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)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2019 Base Plans: N/A					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: AIR WARFARE (AW) ***Description:*** The Air Warfare R-2 Activity, new for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to acquisition programs of record principally under the purview of the Director of Air Warfare (OPNAV N98). ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on extended range targeting, advanced protection from infrared and electro-optic threats, radar electronic attack protection, intelligent collaborative engagements, multifunction capabilities for missile warning sensors, advanced threat aircraft countermeasures, technologies that discriminate and provide terminal guidance for weapons that engage moving targets, numerous advanced weapons technologies, high altitude anti-submarine warfare (ASW), placement and operation of active ASW distributed systems, data exfiltration and networked platform interaction, advanced topcoat systems for air vehicles, air platforms safety and affordability technologies, virtual-constructive representations on live avionics displays for training, and dynamic adaptive and modular training for unmanned aerial systems. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.	0.000	0.000	39.127	0.000	39.127
Title: INFORMATION WARFARE (IW) ***Description:*** The Information Warfare R-2 Activity, new for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to acquisition programs of record principally under the purview of the Deputy Chief of Naval Operations for Information Warfare (N2N6).	0.000	0.000	82.718	0.000	82.718

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
FY 2018 Plans: N/A ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity cover a broad range of rapidly evolving technological areas and include, but are not limited to, those that focus on next-generation command, control and decision support services, cyber security, cyber operations, real-time engagement coordination and performance estimation, next generation countermeasure technologies for ship missile defense, extended distributed weapons coordination, cross field processing and smart use of distributed systems, network collaborative precision navigation and timekeeping, communications and interoperability for integrated fires, shipboard panoramic infrared and electro-optic cueing and surveillance systems, a tactical cloud that exploits cross warfare area data sources, electronic warfare battle management for surface defense, autonomous persistent tactical surveillance, mission-based waveform controls and networking, satellite vulnerability mitigation, comprehensive maritime operational and navigational planning via decision support services, collaborative algorithms for non-GPS-based navigation, technologies that enable real-time situational awareness of tactic-edge internet protocol (IP) networks operating in contested environments, technologies enabling coordination between shipboard and expendable electro-optical/infrared countermeasures, automation technologies that improve theater level anti-submarine warfare operations and multi-domain battle management capabilities. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: SURFACE WARFARE (SW) ***Description:*** The Surface Warfare R-2 Activity, new for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to acquisition programs of record principally under the purview of the Director of Surface Warfare (OPNAV N96). ***FY 2018 Plans:***	0.000	0.000	36.284	0.000	36.284

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on hyper velocity projectiles, full sector torpedo defense, cooperative networked radars, sonar automation, radar resource management for integrated air and missile defense, periscope detection and discrimination, high fidelity active sonar training, anti-ship missile defense, long range detection and tracking, naval interceptor improvements, unmanned systems common control, digital array radars, multifunction shipboard energy storage and power distribution, high power solid state circuit protection, compact power conversion for advanced surface machinery systems, resilient hull and infrastructure mechanical and electrical security, phased array antennas, human injury and treatment models, aluminum alloy corrosion control and prevention, affordable common radar architectures, total ship survivability damage tolerance and recoverability, adaptive training to enhance individual and team learning, and platform design and acquisition tools that reduce manpower. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Title: UNDERSEA WARFARE (UW) ***Description:*** The Undersea Warfare R-2 Activity, new for FY19, focuses on the advanced technology development of new capabilities that leverage the underlying applied research investments in PE 0602750N, Future Naval Capabilities Applied Research. These advanced technology investments align to acquisition programs of record principally under the purview of the Director of Undersea Warfare (OPNAV N97). ***FY 2018 Plans:*** N/A ***FY 2019 Base Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on extended range modular undersea heavyweight vehicle technology for submarine-launched torpedoes, coherent electronic attack capabilities for submarines, vector sensors and signal processing for acoustic arrays, panoramic infrared sensors, technologies for rapid and covert surveillance, electronic sensors for detection of low probability of intercept periscope detection radars, torpedo advanced propulsion systems, simultaneous	0.000	0.000	55.791	0.000	55.791

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
transmit and receive capabilities for submarines, scalable integrated radio frequency systems for undersea platforms, electronic warfare tactical decision aids, tools for predicting array operational loading and distribution, acoustic damping systems, corrosion mitigation technologies that increase operational availability, panoramic photonics mast technologies, hyper-spectral scanning imagery, low light level video cameras, new material development and lab characterization, unmanned aerial system control technologies, adaptive training for submarine navigation and piloting, signature management technologies, and information architectures for improved decision making. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increase from FY18 to FY19 was due to the Navy's restructuring of the FNC Program.					
Accomplishments/Planned Programs Subtotals	237.761	231.772	232.996	0.000	232.996

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The performance metric for this PE is measured by the number of FNCs that transition through an acquisition POR to deploy new capabilities into the Fleet or Force.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	16.442	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	16.442

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 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. Future Naval Capabilities (FNCs) and their associated technology product investments are competitively selected by the Chief of Naval Research under the guidance of a 3-Star oversight group consisting of Navy and Marine Corps senior leaders.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: ASW Research Prog - Cong ***FY 2017 Accomplishments:*** Funds will be used for system development of sensors which will take advantage of the 3D nature of the upper ocean sound structure. ***FY 2018 Plans:*** N/A	6.770	0.000
Congressional Add: Program Increase ***FY 2017 Accomplishments:*** EMW-FY14-01 Compact Wide Area Reconnaissance and Spectral Sensor (CWARSS). Develop the SPRITE CWARSS prototype system, which will provide SWaP-design-traceable sensors and pointing capabilities housed in a dual-pod configuration. EMW-FY15-01 Radar / Context Fusion. Complete the acoustic trade study to determine the type, types, or mix of sensors that best satisfy the TTA metrics within the scenarios provided by the Technology Transfer Agreement. FNT-FY14-03 Data Conditioning. Enhance the MSTI analytic to include METOC forecast model gap-filling, ad-hoc sensor reports, line-of-bearing geo-temporal feature queries, and additional sensor types and characteristic analytics. FNT-FY14-03 Network Adaptive Communication Services. Improve the network health monitoring graphical user interfaces. FNT-FY15-01 Advanced AEW Electronic Protection. Develop, integrate, and test an electronic protection capability.	9.672	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
SHD-FY16-05 Surface Ship Periscope Detection and Discrimination (SSPDD) . Perform advanced data processing and data fusion development. P&E-FY15-03 Multi-Function High Density Shipboard Energy Storage. Characterize the battery module thermal properties, develop a hybrid energy storage module, and perform an integrated Heat Transfer Analysis. P&E-FY17-02 Torpedo Advanced Propulsion System (TAPS). Conduct an assessment of Stored Chemical Energy Propulsion System (SCEPS) technology in regards to safety and cost of the system. SHD-FY16-04 Ship-launched EW Extended Endurance Decoy (SEWEED). Develop a design of the SEWEED platform and payload bay. SHD-FY16-07 Softkill Performance and Real-Time Assessment (SPARTA). Coordinate and conduct requirements analysis, RF propagation studies and measurements, M&S and algorithm software development. ***FY 2018 Plans:*** N/A		
Congressional Adds Subtotals	16.442	0.000

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 technologies within this PE. In all cases, these FNCs support the Department of the Navy's FNC Program and are managed at the Office of Naval Research. At the lowest level, each FNC technology is measured against both technical and financial milestones on a bimonthly basis. Annually, each FNC is reviewed in depth for technical performance and development status by the Chief of Naval Research against goals established when the FNC was first funded. Also annually, each FNC is reviewed by its transition stakeholders for transition commitment. Transition issues and required adjustments are made by the Chief of Naval Research.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	55.555	57.797	58.657	-	58.657	60.500	60.473	61.669	62.923	Continuing	Continuing
1050: *Manufacturing Tech*	0.000	55.555	57.797	58.657	-	58.657	60.500	60.473	61.669	62.923	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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	56.712	57.797	58.832	-	58.832
Current President's Budget	55.555	57.797	58.657	-	58.657
Total Adjustments	-1.157	0.000	-0.175	-	-0.175
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.157	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.175	-	-0.175

Change Summary Explanation

Technical: Not applicable.
Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
1050: *Manufacturing Tech*	0.000	55.555	57.797	58.657	-	58.657	60.500	60.473	61.669	62.923	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)/ COLUMBIA Class (CLB); 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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Composites Processing and Fabrication	7.000	8.000	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)/COLUMBIA Class Submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. ***FY 2018 Plans:*** - Continue Composite Materials and Process Improvement Thrust for VCS/ORP Affordability Initiative. Included efforts to develop/optimize composite materials fabrication technology for reduced cost VCS and ORP construction. - Continue Composite Materials and Process Improvement Thrust for CVN 78 Affordability Initiative. Included efforts to develop/optimize composite materials fabrication technology for reduced cost CVN 78 construction.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue Composite Materials and Process Improvement Thrust for DDG 51 Affordability Initiative. Included efforts to develop/optimize composite materials fabrication technology for reduced cost DDG 51 construction. - Continue Composite Materials and Process Improvement Thrust for JSF Affordability Initiative. Included efforts to develop/optimize composite materials fabrication technology for reduced cost JSF construction. - Continue Composite Materials and Process Improvement Thrust for CH-53K Affordability Initiative. Included efforts to develop/optimize composite materials fabrication technology for reduced cost CH-53K construction. - Continue Composite Materials and Process Improvement Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy ***FY 2019 Base Plans:*** Continue composites processing and fabrication efforts of FY18. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no change from FY 2018 to FY 2019.					
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)/ COLUMBIA Class Submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter. ***FY 2018 Plans:*** - Continued Electronics/Electro-Optics Thrust for JSF Affordability Initiative. Included efforts to improve electronics/ electro-optics affordability for JSF construction. - Continued Electronics/Electro-Optics Thrust for CH-53K Affordability Initiative. Included efforts to improve electronics/ electro-optics affordability for CH-53K construction.	12.000	12.000	12.000	0.000	12.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continued Electronics/Electro-Optics Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. - Continued Electronics/Electro-Optics Thrust for VCS/ORP Affordability Initiative. Included efforts to improve electronics/electro-optics affordability for VCS and ORP construction. - Continued Electronics/Electro-Optics Thrust for DDG 51 Affordability Initiative. Included efforts to improve electronics/ electro-optics affordability for DDG 51 construction. - Continued Electronics/Electro-Optics Thrust for CVN 78 Affordability Initiative. Included efforts to improve electronics/electro-optics affordability for CVN 78 construction. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 Base Plans:*** Continue electronics processing and fabrication efforts of FY18. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no change from FY 2018 to FY 2019.					
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)/COLUMBIA Class Submarine (CLB), 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. ***FY 2018 Plans:*** - Continue Metals Processing Thrust for DDG 51 Affordability Initiative. Included efforts to improve affordability for DDG 51 construction.	12.800	12.000	12.000	0.000	12.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
- Continue Metals Processing Thrust for CVN 78 Affordability Initiative. Included efforts to improve affordability for CVN 78 construction. - Continue Metals Processing Thrust for JSF Affordability Initiative. Included efforts to improve affordability for JSF construction. - Continue Metals Processing Thrust for CH-53K Affordability Initiative. Included efforts to improve affordability for CH-53K construction. - Continue Metals Processing Thrust for other high interest NAVSEA, NAVAIR, and Marine Corps platforms and components. - Continue Repair Technology (RepTech) Thrust to develop, optimize, and transition repair technology for key naval platforms at depots and logistics centers. - Continue Metals Processing Thrust for VCS/OR Affordability Initiative. Includes efforts to improve affordability. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 Base Plans:*** Continue metals processing and fabrication efforts of FY18. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no change from FY 2018 to FY 2019.					
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)/COLUMBIA Class Submarine (CLB), 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 approaches to optimize producibility; intelligent manufacturing planning and factory execution;	23.755	25.797	26.657	0.000	26.657

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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). ***FY 2018 Plans:*** - Continue Manufacturing Enterprise Thrust for DDG 51 Affordability Initiative. Included efforts to improve affordability for DDG 51 construction. - Continue Manufacturing Enterprise Thrust for CVN 78 Affordability Initiative. Included efforts to improve affordability for CVN 78 construction. - Continue Manufacturing Enterprise Thrust for JSF Affordability Initiative. Included efforts to improve affordability for JSF construction. - Continue Manufacturing Enterprise Thrust for CH-53K Affordability Initiative. Included 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. Included 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. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 Base Plans:*** Continue manufacturing enterprise/other processing and fabrication efforts of FY18. Includes support of affordability initiatives for the six acquisition platforms in the Navy ManTech investment strategy. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	55.555	57.797	58.657	0.000	58.657

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)/COLUMBIA Class Submarine (CLB), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K 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/COLUMBIA Class Submarine (VCS/CLB), DDG 51 Class Destroyer, CVN 78 Class Carrier, Joint Strike Fighter (JSF), and CH-53K Heavy Lift Helicopter.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy												Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	39.486	4.878	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.364
2914: *Warfighter Protection Adv Tech*	0.000	4.669	4.878	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.547
9999: *Congressional Adds*	0.000	34.817	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.817

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE)and Project 2914 to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Navy Noise-Induced Hearing Loss research 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. 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	4.789	4.878	4.877	-	4.877
Current President's Budget	39.486	4.878	0.000	-	0.000
Total Adjustments	34.697	0.000	-4.877	-	-4.877
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.302	0.000			
• Program Adjustments	0.000	0.000	-4.877	-	-4.877
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions Adjustments	-0.001	-	-	-	-
• Congressional Add Adjustments	36.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *CW Bill Young Marrow Donor Program*	30.465	0.000
Congressional Add: *Naval Special Warfare Performance and Injury Prevention Program*	4.352	0.000
Congressional Add Subtotals for Project: 9999	34.817	0.000
Congressional Add Totals for all Projects	34.817	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2914: *Warfighter Protection Adv Tech*	0.000	4.669	4.878	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.547

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE)and Project 2914 to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Navy Noise-Induced Hearing Loss research effort.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: NAVAL NOISE-INDUCED HEARING LOSS (NIHL)	4.669	4.878	0.000	0.000	0.000
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 2018 Plans: 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: Complete the effort with the Army, in regenerative medicine (Armed Forces Institute of Regenerative Medicine (AFIRM II).					
FY 2019 Base Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE)and Project 2914 to the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and into the Navy Advanced Technology Project 3433.					
Accomplishments/Planned Programs Subtotals	4.669	4.878	0.000	0.000	0.000

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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	34.817	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.817

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: CW Bill Young Marrow Donor Program ***FY 2017 Accomplishments:*** Increase the enrollment of volunteer donors to the national registry by expanding participation of transplant centers; and improve the accuracy of scientific and clinical matching systems. MAJOR PERFORMERS: National Marrow Donor Program, Minneapolis NM, Naval Medical Research Center, Bethesda MD, and Georgetown University, Washington DC. ***FY 2018 Plans:*** N/A	30.465	0.000
Congressional Add: Naval Special Warfare Performance and Injury Prevention Program ***FY 2017 Accomplishments:*** Collect and analyze data to strategically maximize human capital by reducing the rate of unintentional musculoskeletal injury, sharpen battlefield performance, optimize military readiness, extend tactical life cycle and enhance the quality of life after service. ***FY 2018 Plans:*** N/A	4.352	0.000
Congressional Adds Subtotals	34.817	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: PB 2019 Navy												Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	25.352	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.352
2916: *Undersea Warfare Advanced Technology*	0.000	25.352	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.352

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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	25.880	0.000	0.000	-	0.000
Current President's Budget	25.352	0.000	0.000	-	0.000
Total Adjustments	-0.528	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.528	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2916: *Undersea Warfare Advanced Technology*	0.000	25.352	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.352

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Naval Forces UUV Development	25.352	0.000	0.000	0.000	0.000
Description: Develop critical technology for Long Displacement Unmanned Underwater Vehicle (LDUUV) to meet 30+ days. Critical technology includes Energy, Autonomy, and Endurance. Innovative Naval Prototype (INP) - Large Displacement UUV (LDUUV) The funding decrease for FY 2018 reflects the realignment of the Large Displacement UUV INP Program and the Anti-Submarine Warfare (ASW) Mission Package program to the new PE 0603801N Innovative Naval Prototypes Advanced Technology Development. ***FY 2018 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no difference between FY18 and FY19.					
Accomplishments/Planned Programs Subtotals	25.352	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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.
- 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	67.965	64.889	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	132.854
2918: *Navy Warfighting Experiments and Demo*	0.000	67.965	64.889	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	132.854

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Naval Warfare Experimentation, Operations Analysis, Swampworks, Tech Solutions, and Precision Strike Technology research efforts.

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.

A new activity was moved into this PE in 2018 - Precision Strike Technology, formerly funded in PE 0603114N Power Projection Advanced Technology.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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*		
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	60.550	64.889	68.128	-	68.128
Current President's Budget	67.965	64.889	0.000	-	0.000
Total Adjustments	7.415	0.000	-68.128	-	-68.128
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	9.214	0.000			
• SBIR/STTR Transfer	-0.764	0.000			
• Program Adjustments	0.000	0.000	-68.128	-	-68.128
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions Adjustments	-0.035	-	-	-	-
• Congressional Directed Reductions Adjustments	-1.000	-	-	-	-

Change Summary Explanation

The FY 2019 funding decrease reflects the realignment of funding to PE 0603671N Navy Advanced Technology Development.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2918: *Navy Warfighting Experiments and Demo*	0.000	67.965	64.889	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	132.854

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Naval Warfare Experimentation, Operations Analysis, Swampworks, Tech Solutions, and Precision Strike Technology research efforts.

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: NAVAL WARFARE EXPERIMENTATION	30.902	18.731	0.000	0.000	0.000
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.					
FY 2018 Plans: - Continue efforts to address the priorities of the Chief of Naval Research and the Chief of Naval Operations					
FY 2019 Base Plans: N/A					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
Title: OPERATIONS ANALYSIS ***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 2018 Plans:*** - Conducte 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. - Continue efforts in support of Fleet/Force. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.	3.019	2.017	0.000	0.000	0.000
Title: SWAMPWORKS ***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	24.341	22.563	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
Title: TECH SOLUTIONS	9.703	9.186	0.000	0.000	0.000
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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2018 Plans:*** - Continue development of projects that will provide solutions to address emergent critical needs. - Continue rapid response S&T projects in direct support of Fleet/Force needs. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
Title: PRECISION STRIKE TECHNOLOGY	0.000	12.392	0.000	0.000	0.000
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 FY 2018, this effort was funded in PE 0603114N Power Projection Advanced Technology Development ***FY 2018 Plans:*** Efforts in this area support Naval Precision Strike Operations, providing the Navy capability to quickly locate, target, and strike critical targets. ***FY 2019 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2918 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
Accomplishments/Planned Programs Subtotals	67.965	64.889	0.000	0.000	0.000

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy												Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	12.676	15.164	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	27.840
2917: *Shallow Water MCM Demos*	0.000	12.676	15.164	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	27.840

Note

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2917 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Joint EOD Demonstrations and Mine Technology research efforts.

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 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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*

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	15.167	15.164	13.172	-	13.172
Current President's Budget	12.676	15.164	0.000	-	0.000
Total Adjustments	-2.491	0.000	-13.172	-	-13.172
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.468	0.000			
• Program Adjustments	0.000	0.000	-13.172	-	-13.172
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions Adjustments	-0.023	-	-	-	-
• Congressional Directed Reductions Adjustments	-2.000	-	-	-	-

Change Summary Explanation

The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2917 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433. Specific efforts transferred from this PE include all planned continuing and initiating research associated with the Joint EOD Demonstrations and Mine Technology research efforts.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
2917: *Shallow Water MCM Demos*	0.000	12.676	15.164	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	27.840

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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Joint EOD Demos	1.859	1.958	0.000	0.000	0.000
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: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 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 2018 Plans:*** Conduct advanced technology development and demonstration in electro-optic & acoustic technologies for buried mine detection, robotic manipulation for ordnance exploitation & neutralization, standoff detection 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 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2917 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
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,	10.817	13.206	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2018 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 thrust include prototyping advanced sensors and sensor configuration technologies for improved discrimination as well as communications, command, and control technologies. ***FY 2019 Base Plans:*** N/A ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The funding decrease from FY18 to FY19 reflects the realignment and consolidation of resources from the current Program Element (PE) and Project 2917 into the new FY19 Navy Advanced Technology Development (ATD) PE 0603671N, and the Navy Advanced Technology Project 3433.					
Accomplishments/Planned Programs Subtotals	12.676	15.164	0.000	0.000	0.000

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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*

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-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	0.000	0.000	108.285	161.859	-	161.859	86.898	86.858	88.576	90.378	Continuing	Continuing
3400: *Innovative Naval Prototypes (INP) Adv Tech Dev*	0.000	0.000	108.285	161.859	-	161.859	86.898	86.858	88.576	90.378	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. 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 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 modified or established to support further development. These investments are selected by a process that involves senior leadership in the Department of the Navy.

Developing INPs 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 technology becomes available for transition and further development within an emerging or new Program of Record. INPs 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 PE was new for FY 2018 and consolidated all Navy 6.3 investments funding INP 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. Accordingly, the projects in the portfolio are no longer distinguished as INPs or Leap Ahead-Technologies. Rather, they are now referred to simply as INPs.

Due to the nature of these projects, starting in FY19, plans have been written with limited details due to information security concerns. Specific information on each project will be provided separately to the Congressional oversight committees.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	0.000	108.285	86.342	-	86.342
Current President's Budget	0.000	108.285	161.859	-	161.859
Total Adjustments	0.000	0.000	75.517	-	75.517
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	76.000	-	76.000
• Rate/Misc Adjustments	0.000	0.000	-0.483	-	-0.483

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
3400: *Innovative Naval Prototypes (INP) Adv Tech Dev*	0.000	0.000	108.285	161.859	-	161.859	86.898	86.858	88.576	90.378	Continuing	Continuing

A. Mission Description and Budget Item Justification

INP and LA-Tech 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. It is intended that prototypes developed within this program, requiring both BA2 and BA3 funding, are demonstrated in a relevant environment to prove the feasibility of the new technological capability. The portfolio is periodically refreshed through the selection of new INPs and LA-Tech investments as existing ones are completed. Successful experimentations and 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 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.

Due to the nature of these projects, starting in FY19, plans have been written with limited details due to information security concerns. Specific information on each project will be provided separately to the Congressional oversight committees.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Cyber	0.000	5.238	12.692	0.000	12.692
Description: This R-2 Activity contains all BA3 Innovative Prototype (INP) investments that are developing new technologies for cyber warfare. Potential adversaries are investing in advanced technologies that will challenge our advantages in the critical information domain. Nation states and non-state actors seek to degrade our command and control capabilities, networks and computer systems. Cyber threats continue to grow and rapidly proliferate. Technologies developed in this R-2 Activity will enable the warfighter to take immediate, appropriate action at any time against any desired adversary, target or network by assuring that autonomous, continuous analyses of intelligence, persistent surveillance and open information sources have, at all times, optimized the possible courses of action based on commander's guidance. Technologies within this activity will foster operational endurance and enable sustained operations and resiliency for warfighters and platforms through enhanced cyber security/protection. ***FY 2018 Plans:*** Total Platform Cyber Protection (TPCP) Initiate the BA 3 effort for the TPCP project, previously funded in PE 0602123N Force Protection Applied Research, which will develop leap-ahead resilient cybersecurity tools to enable our warfighting platforms to					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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 2019 Base Plans:*** Continue developing the Technology to support enhanced Fleet/Force cyber protection and mitigation. Continue the BA3 effort to develop resilient cybersecurity tools that will enable our warfighting platforms to fight through current and future cyber intrusions. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 increase is due to an increase in funding applied to the development of capabilities to provide cyber protection for two of the program's eight identified common layers of cyber platform functionality, in an effort to improve overall naval platform cyber resiliency and warfighting effectiveness.					
Title: Directed Energy / Electric Weapons	0.000	35.529	98.747	0.000	98.747
Description: This R-2 Activity contains all BA3 Innovative Prototype (INP) investments that are developing new technologies for directed energy and electric weapons. Future adversaries will seek to neutralize U.S. conventional advantages by capitalizing on asymmetric capabilities that incorporate mobility, range, speed and deception. Naval platforms will be on the front line of our national integrated defensive capabilities to defeat these emerging threats that are proliferating. At the same time, the fleet/force must be able to effectively strike					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
targets with survivable, scalable and cost-effective weapons that have sufficient range, speed and accuracy to complete a variety of missions while reducing risk to our warfighters and without creating unnecessary collateral damage or loss of life. Technologies within this activity will provide scalable lethality through enabling multi-domain, integrated, scalable kinetic and non-kinetic systems for offensive of defensive purposes. The FY18 to FY19 increase is due to increased investment for the continued and accelerated development of laser weapon systems, initial sea-based testing of these systems, and research supporting systems integration into naval surface platforms. ***FY 2018 Plans:*** Electro-Magnetic Railgun (EMRG) Continue EMRG, which was previously funded in 0603114N Force Protection Advanced Technology Development and PE 0603123N 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. Solid State Laser Technology Maturation (SSL TM) Continue 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. High-power Joint Electromagnetic Non-Kinetic Strike (HIJENKS) Continue HIJENKS, a joint USAF/USN project previously funded as a FY17 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					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
system interoperability; begin live fire demonstration planning; and begin conceptually designing the next generation RF source technology. ***FY 2019 Base Plans:*** Continue advanced technology development and studies focused on marinizing an operational laser weapon system, expanded efforts supporting and conducting sea-based developmental testing, and research supporting future systems integration of surface ship laser weapons. Initiate advanced technology development efforts to evaluate the potential performance of an alternative laser source for future Surface Navy Laser Weapons System increments. Continue conducting BA3 development addressing the unique technical challenges inherent in the construction, assembly and operation of a high-power, kinetic energy weapon prototype capable of launching long range projectiles repeatedly. Continue BA3 efforts to develop a radio frequency effects payload (a joint USAF/USN project) with scalable electromagnetic effects. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 increase is due to increased investment for the continued and accelerated development of laser weapon systems, initial sea-based testing of these systems, and research supporting systems integration into naval surface platforms.					
Title: Electromagnetic Maneuver Warfare ***Description:*** This R-2 Activity contains all 6.3 Innovative Prototype (INP) investments that are developing new technologies for Electromagnetic Maneuver Warfare (EMW). The electromagnetic spectrum is a key operational maneuver space enabled by continuous, real-time awareness of all spectrum activity. This R-2 Activity supports spectrum dominance which included efforts that focus on communications, surveillance, EW and electronics to understand and shape the battle space. The ability to assure access to the full spectrum is essential for battle space awareness and threat surveillance/weapon sensor engagement. Technologies within this activity will provide for integrated and distributed forces capable of dynamic synchronized actions through interoperable	0.000	16.839	16.093	0.000	16.093

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
forces by incorporation of autonomous / disaggregated systems to increase flexibility and reach within the electromagnetic spectrum. ***FY 2018 Plans:*** 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. Nemesis 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 2019 Base Plans:*** Continue BA3 to develop technology which will enable a strike group to work cooperatively in the Electromagnetic Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), communications, and radar performance. ***FY 2019 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease is due to the completion of a distributed EW systems project and a decrease in funding for an electromagnetic spectrum agility effort (in the program's second to last year).					
Title: Undersea Warfare ***Description:*** This R-2 Activity contains all BA3 Innovative Prototype (INP) investments that are developing new technologies for Undersea Maneuver Warfare. This R-2 Activity explores development of technologies to achieve and maintain undersea dominance in the areas of ASW and mine warfare, and to improve environmental sensing capabilities which support the Undersea Warfare domain. Technologies within this activity will dramatically improve sensing and sense-making, provide integrated and distributed autonomy to forces, and provide scalable lethality through development of kinetic and non-kinetic effects payloads. ***FY 2018 Plans:*** Forward Deployed Energy & Communications Outpost (FDECO) Complete 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 notional intelligence preparation of the operational environment and begin demonstrating notional mine warfare and anti-submarine warfare capabilities. Anti-Submarine Warfare Mission Packages (ASW MP) Complete ASW MP, which was previously funded in PE 0603747N Undersea Warfare Advanced Technology Development. The ASW MP is developing a system of ASW sensors and autonomy algorithms for undersea systems. ***FY 2019 Base Plans:*** Complete BA3 efforts to develop next generation ASW capability. ***FY 2019 OCO Plans:***	0.000	13.168	1.490	0.000	1.490

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY18 to FY19 decrease is due primarily to the completion of an undersea warfare technology development project.					
Title: Unmanned and Autonomous Systems ***Description:*** This R-2 Activity contains all BA3 Innovative Prototype (INP) investments that are developing new technologies for Unmanned and Autonomous Systems. Increased proliferation of inexpensive lethal threats targeting individual warfighters and high-value assets, combined with continued rapid advances in computing, power and energy, robotics, sensors and position guidance technologies, drives the requirement to augment expensive manned systems with less expensive, unmanned, fully autonomous systems that can operate in all domains. Technologies within this activity will provide integrated and distributed, autonomous and disaggregated systems to increase flexibility and reach. ***FY 2018 Plans:*** Autonomous Aerial Cargo/Utility System (AACUS) 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. Claws Initiate Claws which 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	0.000	37.511	32.837	0.000	32.837

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
effort in PE 0602792N. Analysis of promising technologies will be conducted using laboratory and at-sea testing to provide realistic performance data. 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. 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, reconnaissance and kinetic strike payloads. Medium Displacement Unmanned Surface Vehicle (MDUSV)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue the MDUSV project, which was previously funded predominantly 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 MDUSV 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. 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 2019 Base Plans:*** Continue BA3 development of autonomous payloads for large and extra-large unmanned undersea vehicles. Continue BA3 development of autonomy algorithms, the command and control architecture needed for swarm control (a flying ad-hoc network), effects payloads and sensing modalities. Continue BA3 development and integration of autonomy systems and various mission area payloads onto unmanned surface vehicles. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
The overall FY18 to FY19 decrease is due to a significant reduction of funding levels associated with the completion of three unmanned and autonomous systems technology development projects, countered by an increase in funding in the second year of two FY18 new start INPs.					
Accomplishments/Planned Programs Subtotals	0.000	108.285	161.859	0.000	161.859

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. Technology development is informed by periodic interaction with Naval warfighters, resource sponsors and the acquisition community. At the lowest level, each project is evaluated against technical and financial milestones on a 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 is briefed on the portfolio's status by the Chief of Naval Research.

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