Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy											Date: March 2019	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 7: *Operational Systems Development*					R-1 Program Element (Number/Name) PE 0204228N *I Surface Support*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	60.416	20.587	9.708	36.389	-	36.389	33.116	19.896	15.166	15.470	Continuing	Continuing
3311: *Navigation Systems*	60.416	20.587	9.708	36.389	-	36.389	33.116	19.896	15.166	15.470	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Surface Support RDT&E funding will be used for the research, design, development, integration testing, and documentation of a new Inertial Navigation System (INS) AN/WSN-12 for all Navy platforms. The INS provides mission critical ship's position and attitude data to shipboard sensors (such as radars), combat systems, gun, and missile systems. The INS uses data from the Global Positioning System (GPS) to periodically update (i.e., reset) its position and internal clock. The INS is the ship's primary position source in the absence of GPS. The INS AN/WSN-12 consists of an Inertial Sensor Module (ISM) and a Navigation Processing Module (NPM) that will provide a significant improvement with respect to attitude and velocity data over previous INS through the use of Power Spectral Density (PSD) capability. PSD provides a tighter tolerance for error across a wider frequency range. The ISM is being designed, developed, and procured through a competitive contract awarded to Northrop Grumman in November 2015. The NPM is a Government design. The government will serve as integration agent prior to the next AN/WSN-12 competitive award scheduled for January 2022. RDT&E funding will support continued system design to create a baseline for Pre-Production Units (PPU), Low Rate Initial Production (LRIP), and Full Rate Production (FRP). The system will go through Critical Design Review (CDR), Test Readiness Review (TRR), and Production Readiness Reviews (PRR). The system will go through extensive testing including Independent Validation and Verification (IV&V), Developmental Testing (DT) and Operational Testing (OT). Planned FY 2020 efforts include conduct of Physical Configuration Audit (PCA) and completion of logistics documentation.

Cybersecurity funding will be used for the research, development, documentation and integration testing for cybersecurity hardening and enclave development for navigation systems. Efforts will include the development of boundary defense capabilities, platform specific architectures, Navy-Electronic Chart Display and Information System (Navy-ECDIS) secure solution for existing unclassified configurations and CYBERSAFE implementation and conduct of cybersecurity risk and vulnerability assessments including development of system models, threat models, and mission models for representative groupings of Navigation systems and cybersecurity capabilities. Risk assessments along with requirements development will lead to incremental capability development leveraging the Increment 1 Engineering Development Model (EDM) delivery with updated architectures and system level modifications. Follow on capabilities will be developed and added to meet existing threats and requirements. Planned FY 2020 efforts include Cross Domain Solution (CDS) and cyber capability Increment 2 development.

Time and Frequency Distribution System-Replacement (TFDS-R) funding will be used for the research, development, documentation, and integration testing for the Submarine TFDS-R system. TFDS is a Commercial Off the Shelf (COTS) timing system utilizing the precision source signals of GPS to discipline two redundant Rubidium clocks to Universal Coordinated Time (UTC). TFDS provides common time to submarine equipment that utilizes clocking pulses or sinusoidal waveforms for proper operation and maintains accurate time in the event of loss of GPS input (holdover). TFDS Uses multiple input power sources for redundancy and provides a built in battery backup. TFDS generates and distributes Precision Time and Timing Interval (PTTI) reference signals to support C4I capabilities needed for Joint, Naval and Allied missions. This funding will be used to conduct a system level Analysis of Alternatives (AoA) and develop a Technical Requirements Document (TRD). These documents will support detailed analysis of the program implementation strategy to replace obsolete TFDS systems in the fleet including appropriate documentation and contracting strategies. Planned FY 2020 efforts include development of an Engineering Development Model (EDM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy	Date: March 2019
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 7: *Operational Systems Development*	**R-1 Program Element (Number/Name)** PE 0204228N *I Surface Support*

Military GPS User Equipment (MGUE) will provide assured Positioning, Navigation and Timing (PNT) in a GPS degraded environment. Funding will be used for development of interface and performance requirements, shipboard system architecture definition, and MGUE integration into SSNs, Tomahawk, and Advanced Anti-Radiation Guided Missile (AARGM). Planned FY 2020 efforts include early integration with combat/weapons control and other critical systems.

Submarine Speed Sensors will provide investigation, development, testing, and integration of new Own-Ship Speed sensors to address new capabilities, reduce detection, and improve reliability. Planned FY 2020 efforts include Environmental Qualification Testing of Doppler sensor.

As part of the Future Navy Capability initiative, Assured Positioning, Navigation, and Timing (APNT) funding will be used for Alternate GPS-independent sources of Positioning, Velocity, Attitude, and Timing (PVAT) data required to provide fire control solutions, ensure safety of navigation, and support aircraft and combat operations in a GPS degraded/denied environment. This effort provides a secure navigation method using the Cooperative Engagement Capability (CEC) network and corresponding time and navigation resources being developed via ONR Future Naval Capabilities (FNC) activity. CEC is a critical component of Naval Integrated Fire Control (NIFC) efforts and Integrated Air and Missile Defense (IAMD). Fleet Priority: CEC Non-GPS Aided Positioning for Surface and Submarine (NoGAPSS) addresses 15 Integrated Priorities Capability List (IPCL) Gaps (IAMD 1,4,5,6,7,8,9,10; SUW 1,3,4,6; EW 3; ASW 1,2).

As part of the Future Navy Capability initiative, Automated Celestial Navigation System (ACNS) funding will be used for the research, development, Engineering Development Model (EDM), documentation and integration testing of the celestial navigation solution for the No Gaps navigation implementation on the fleet. Efforts will leverage ONR celestial navigation research into a reproducible ruggedized system fully integrated into the navigation suite. FY 2020 efforts include release of development contract.

As part of the Future Navy Capability initiative, Navigation Suite funding will be used to conduct analyses and studies on impact of the PVAT Navy Integrating Capability Construct (NICC) to validate, verify and test latency requirements to combat systems consumers. Efforts will include analysis and planning for the alignment and evolution of Afloat Navigation Systems for surface and submarine platforms and development of Capability Phasing Planning (CPP) processes to drive engineering analysis. The program will implement systems engineering processes to investigate major navigation system error sources, define new functions, research new technologies, algorithms, and techniques to improve system performance, conduct analyses of alternatives, create preliminary and final design concepts, develop new hardware components and associated software, and conduct land based and shipboard testing. Funding will also be used to research and integrate electronic charts into mission planning tools and other combat system elements to provide improved fidelity and commonality among elements and improve navigation awareness in compliance with Navy NAVWAR policies including integration of a Secondary Control Display Unit (SCDU) for the bridge on Surface Platforms. Additional research and integration testing will be conducted for a horizontal plotter display for Navy ECDIS to replace existing chart tables and other navigation oriented tables shipboard.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy					Date: March 2019
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 7: *Operational Systems Development*		R-1 Program Element (Number/Name) PE 0204228N *I Surface Support*			
B. Program Change Summary ($ in Millions)	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**
Previous President's Budget	24.829	11.661	23.589	-	23.589
Current President's Budget	20.587	9.708	36.389	-	36.389
Total Adjustments	-4.242	-1.953	12.800	-	12.800
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-1.953			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.000	0.000			
• SBIR/STTR Transfer	-0.496	0.000			
• Program Adjustments	0.000	0.000	12.800	-	12.800
• Rate/Misc Adjustments	0.001	0.000	0.000	-	0.000
• Congressional Directed Reductions Adjustments	-2.747	-	-	-	-

Change Summary Explanation

The FY 2020 increase supports the Future Navy Capability initiative for Assured Positioning, Navigation, and Timing (APNT), Automated Celestial Navigation System (ACNS), and associated Navigation Suite.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy			Date: March 2019
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0204228N / *Surface Support*	Project (Number/Name) 3311 / *Navigation Systems*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
3311: *Navigation Systems*	60.416	20.587	9.708	36.389	-	36.389	33.116	19.896	15.166	15.470	Continuing	Continuing
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

Military GPS User Equipment (MGUE) will provide assured Positioning, Navigation and Timing (PNT) in a GPS degraded environment. Funding will be used for development of interface and performance requirements, shipboard system architecture definition, and MGUE integration into SSNs, Tomahawk, and Advanced Anti-Radiation Guided Missile (AARGM). Planned FY 2020 efforts include early integration with combat/weapons control and other critical systems.

Submarine Speed Sensors will provide investigation, development, testing, and integration of new Own-Ship Speed sensors to address new capabilities, reduce detection, and improve reliability. Planned FY 2020 efforts include Environmental Qualification Testing of Doppler sensor.

As part of the Future Navy Capability initiative, Assured Positioning, Navigation, and Timing (APNT) funding will be used for Alternate GPS-independent sources of Positioning, Velocity, Attitude, and Timing (PVAT) data required to provide fire control solutions, ensure safety of navigation, and support aircraft and combat operations in a GPS degraded/denied environment. This effort provides a secure navigation method using the Cooperative Engagement Capability (CEC) network and corresponding time and navigation resources being developed via ONR Future Naval Capabilities (FNC) activity. CEC is a critical component of Naval Integrated Fire Control (NIFC) efforts and Integrated Air and Missile Defense (IAMD). Fleet Priority: CEC Non-GPS Aided Positioning for Surface and Submarine (NoGAPSS) addresses 15 Integrated Priorities Capability List (IPCL) Gaps (IAMD 1,4,5,6,7,8,9,10; SUW 1,3,4,6; EW 3; ASW 1,2).

As part of the Future Navy Capability initiative, Automated Celestial Navigation System (ACNS) funding will be used for the research, development, Engineering Development Model (EDM), documentation and integration testing of the celestial navigation solution for the No Gaps navigation implementation on the fleet. Efforts will leverage ONR celestial navigation research into a reproducible ruggedized system fully integrated into the navigation suite. FY 2020 efforts include release of development contract.

As part of the Future Navy Capability initiative, Navigation Suite funding will be used to conduct analyses and studies on impact of the PVAT Navy Integrating Capability Construct (NICC) to validate, verify and test latency requirements to combat systems consumers. Efforts will include analysis and planning for the alignment and evolution of Afloat Navigation Systems for surface and submarine platforms and development of Capability Phasing Planning (CPP) processes to drive engineering analysis. The program will implement systems engineering processes to investigate major navigation system error sources, define new functions, research new technologies, algorithms, and techniques to improve system performance, conduct analyses of alternatives, create preliminary and final design concepts, develop new hardware components and associated software, and conduct land based and shipboard testing. Funding will also be used to research and integrate electronic charts into mission planning tools and other combat system elements to provide improved fidelity and commonality among elements and improve navigation awareness in compliance with Navy NAVWAR policies including integration of a Secondary Control Display Unit (SCDU) for the bridge on Surface Platforms. Additional research and integration testing will be conducted for a horizontal plotter display for Navy ECDIS to replace existing chart tables and other navigation oriented tables shipboard.

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: AN/WSN-12 Inertial Navigation System - Replacement (INS-R)	10.824	7.648	7.800	0.000	7.800
Articles:	-	-	-	-	-
FY 2019 Plans: Begin NPM PPU EQT testing Begin ISM PPU EQT testing					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Complete ISM PPU builds Complete NPM PPU builds Begin PPU integration and interface testing Begin system level PPU land based performance testing ***FY 2020 Base Plans:*** Complete EQT testing Complete integration and interface testing Procure LRIP units Begin OT with land based test sites for combat system integration ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Increase within inflation (2%).					
Title: Cybersecurity	2.057	0.500	5.016	0.000	5.016
Articles:	-	-	-	-	-
FY 2019 Plans: Complete BDC Requirements development Continue BDC Increment 1 capability development Continue development of Cross Domain Solution (CDS) ***FY 2020 Base Plans:*** Complete BDC Increment 1 capability Continue CDS development Develop CVN architecture Begin Integrated Positioning Navigation, and Timing (iPNT) development Conduct surface integration Begin development of Increment 2 capabilities of boundary defense Field cyber pilot ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
The FY 20 increase supports the Future Navy Capability Initiative which includes the development and redesign of Navigation Cyber Enclave architectures; development of cross domain solutions with interfacing systems; begin Integrated Positioning Navigation, and Timing (iPNT) development; and development of statutory Military GPS User Equipment integration.					
Title: Time Frequency Distribution System (TFDS) Replacement	2.000	0.200	1.900	0.000	1.900
Articles:	-	-	-	-	-
FY 2019 Plans: Refine/update RFI					
FY 2020 Base Plans: Release RFI Develop Engineering Development Model (EDM) Conduct land based system level testing					
FY 2020 OCO Plans: N/A					
FY 2019 to FY 2020 Increase/Decrease Statement: The increase in FY 20 is commensurate with increased effort planned to advance analysis, development, test and validation of capabilities to replace the increasingly unsupportable Submarine Time Frequency Distribution System (TFDS).					
Title: Military GPS User Equipment (MGUE)	3.906	0.680	6.790	0.000	6.790
Articles:	-	-	-	-	-
FY 2019 Plans: Support integration testing with antenna upgrade Begin integration plan for MGUE into the ECDU					
FY 2020 Base Plans: Begin MGUE card integration into ECDU Complete platform level integration studies for munitions and GPS end users Begin TI-22 EDM integration testing with combat system users					
FY 2020 OCO Plans: N/A					
FY 2019 to FY 2020 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Increase to support surface integration and testing beginning in FY 2020.					
Title: Submarine Speed Sensors (SSS) ***Articles:*** ***FY 2019 Plans:*** N/A ***FY 2020 Base Plans:*** Complete flow tank testing and prepare for at-sea testing Conduct Environmental Qualification Testing of Doppler prototype ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The increase in FY 20 is commensurate with increased effort planned to advance analysis, development, test and validation of the Submarine Speed Sensor (SSS), to include Environmental Qualification Testing (EQT) and simulated operating environment testing of the SSS prototype.	0.800 -	0.000 -	1.200 -	0.000 -	1.200 -
Title: Assured Positioning, Navigation, and Timing (APNT) ***Articles:*** ***FY 2019 Plans:*** N/A ***FY 2020 Base Plans:*** Conduct ACNS/GPNTS/WSN Focused Demos ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** New initiative in FY 2020	0.000 -	0.000 -	3.600 -	0.000 -	3.600 -
Title: Automated Celestial Navigation System (ACNS) ***Articles:*** ***FY 2019 Plans:*** N/A ***FY 2020 Base Plans:***	0.000 -	0.000 -	3.200 -	0.000 -	3.200 -

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Finalize System Requirements Document Finalize external interface description/controls Receive ONR Technical Data Award ACNS Development Contract ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** New initiative in FY 2020					
Title: Navigation Suite	0.000	0.000	4.700	0.000	4.700
Articles:	-	-	-	-	-
FY 2019 Plans: N/A ***FY 2020 Base Plans:*** Conduct studies and analyses on platform integration improvements Conduct integration of chart services for use by Combat Systems, mission planning tools and other shipboard systems Develop and plan for integrated navigation Land Based Test Site (LBTS) Develop future integrated PVAT suite architecture Develop navigational awareness improvements including integration of a Secondary Control Display Unit (SCDU) Develop horizontal plotter display capability for ECDIS Improve navigation situational awareness including collision avoidance technology measures and surface track commonality Research capability to correlate AIS and radars for a common surface contact picture Collaborate with external organizations like DARPA and DIUX to research availability of automated collision avoidance systems ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
New initiative in FY 2020					
Title: Navigation Support	1.000	0.680	2.183	0.000	2.183
Articles:	-	-	-	-	-
FY 2019 Plans: Provide engineering, logistics, and programmatic support for, AN/WSN-12, Cybersecurity, TFDS, MGUE, SSS, ACNS, APNT, and Navigation Suite.					
FY 2020 Base Plans: Provide engineering, logistics, and programmatic support for, AN/WSN-12, Cybersecurity, TFDS, MGUE, SSS, ACNS, APNT, and Navigation Suite.					
FY 2020 OCO Plans: N/A					
FY 2019 to FY 2020 Increase/Decrease Statement: The Navigation Support amount is directly based on the total amount of the other RDTE efforts. For FY 2019, the support efforts identified are being conducted, but at a minimal level. For FY 2020, increased support will be expected in the identified areas due to the new Future Navy Capability efforts and full funding of the other RDTE efforts.					
Accomplishments/Planned Programs Subtotals	20.587	9.708	36.389	0.000	36.389

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
• OPN/0670: *Other Navigation*	62.427	60.830	77.404	-	77.404	73.153	74.297	75.709	66.846	Continuing	Continuing

Remarks

D. Acquisition Strategy

AN/WSN-12 Inertial Sensor Module (ISM) CPIF/CPFF/FFP contract competitively awarded in FY 2016. Contract includes options for conducting R&D milestones, manufacture of Engineering Development Models (EDM) and Pre-Production Units (PPU), and manufacture of Low Rate Initial Production (LRIP) and Full Rate Production (FRP). Planned FY 2020 efforts include start of competitive acquisition of AN/WSN-12 with delivery of Technical Data Package.

E. Performance Metrics

FY 2018

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

Conduct AN/WSN-12 Critical Design Review (CDR)
Develop Cybersecurity Prototype Increment 1 design and ECDIS controlled interface completed design
Execute TFDS Program of Record activities
Complete GPS MGUE Trade Studies
Develop new Doppler prototype

FY 2019
Complete ISM PPU builds and deliver
Complete NPM PPU builds and deliver
Start AN/WSN-12 system level PPU land based performance testing
Start AN/WSN-12 ILS planning
Complete cyber prototype Increment 1
Receive M-Code receiver and begin early integration with HAE2 Level Card

FY 2020
Complete AN/WSN-12 DT
Complete AN/WSN-12 PCA/FCA
Procure AN/WSN-12 LRIP units
Start AN/WSN-12 combat system integration planning
Complete cyber requirements studies
Complete cyber chart services studies
Complete cyber plan for land based test site
Complete CVN cyber architecture
Complete SCDU prototype
Complete integration testing for horizontal plotter
Complete requirements analysis and study for surface correlation capability
Complete requirements development and integration plan for collision avoidance capability
Develop TFDS EDM
Award ACNS Development Contract
Conduct ACNS/GPNTS/WSN Focused Demos

Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Navy			Date: March 2019
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0204228N / *Surface Support*	Project (Number/Name) 3311 / *Navigation Systems*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Systems Engineering/ Design	WR	SPAWAR Atlantic : Little Creek, VA	6.050	1.980	Jan 2018	1.762	Jan 2019	8.840	Dec 2019	-		8.840	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	SPAWAR Pacific : San Diego, CA	0.660	0.615	Jan 2018	0.000		0.600	Dec 2019	-		0.600	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	WR Systems : Norfolk, VA	9.476	5.151	Jan 2018	1.350	Jan 2019	3.650	Mar 2020	-		3.650	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	Penn State/ARL : Warminster, PA	3.475	0.693	Aug 2018	0.000		0.500	Dec 2019	-		0.500	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NSWC Dahlgren : Dahlgren, VA	0.643	0.000		0.000		2.000	Dec 2019	-		2.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NSWC Dam Neck : Dam Neck, VA	0.340	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NSWC PHD : Port Hueneme, CA	0.122	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NUWC Newport : Newport, RI	0.180	0.000		0.000		0.500	Dec 2019	-		0.500	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	Old Dominion University : Suffolk, VA	0.450	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	Northrop Grumman : Charlottesville, VA	27.542	7.444	Dec 2017	4.736	Jan 2019	2.800	Mar 2020	-		2.800	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	SPAWAR Atlantic : Charleston, SC	1.530	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NSWC Philadelphia : Philadelphia, PA	0.550	0.187	Feb 2018	0.000		0.500	Dec 2019	-		0.500	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	Electric Boat : Groton, CA	0.953	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	John Hopkins, APL : Laurel, MD	1.638	3.342	Aug 2018	1.180	Jan 2019	10.216	Dec 2019	-		10.216	Continuing	Continuing	Continuing
Systems Engineering/ Design	C/CPFF	Draper : Cambridge, MA	1.475	0.000		0.000		1.500	Dec 2019	-		1.500	Continuing	Continuing	Continuing
Systems Engineering/ Design	WR	NSWC Crane : Crane, IN	0.060	0.061	Nov 2017	0.000		0.000		-		0.000	0.000	0.121	-

Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Navy			Date: March 2019
Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0204228N / *Surface Support*	Project (Number/Name) 3311 / *Navigation Systems*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Systems Engineering/ Design	WR	Submarine Special Projects : Washington, DC	0.000	0.000		0.000		0.000		-		0.000	0.000	0.000	-
Systems Engineering/ Design	MIPR	COMOPTEVFOR : Norfolk, VA	0.000	0.021	Jun 2018	0.000		0.000		-		0.000	0.000	0.021	-
Systems Engineering/ Design	WR	SPAWAR 5.0 : San Diego, CA	0.000	0.093	Jul 2018	0.000		0.000		-		0.000	0.000	0.093	-
Systems Engineering/ Design	TBD	ACNS Contract : TBD	0.000	0.000		0.000		2.700	Mar 2020	-		2.700	0.000	2.700	-
Systems Engineering/ Design	TBD	Carnegie Mellon : Not Specified	0.000	0.000		0.000		0.400	Dec 2019	-		0.400	0.000	0.400	-
		Subtotal	55.144	19.587		9.028		34.206		-		34.206	Continuing	Continuing	N/A

Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Program Management	C/CPFF	Various : Not Specified	5.272	1.000	Jan 2018	0.680	Jan 2019	2.183	Jan 2020	-		2.183	Continuing	Continuing	Continuing
		Subtotal	5.272	1.000		0.680		2.183		-		2.183	Continuing	Continuing	N/A

	Prior Years	FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	60.416	20.587		9.708		36.389		-		36.389	Continuing	Continuing	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

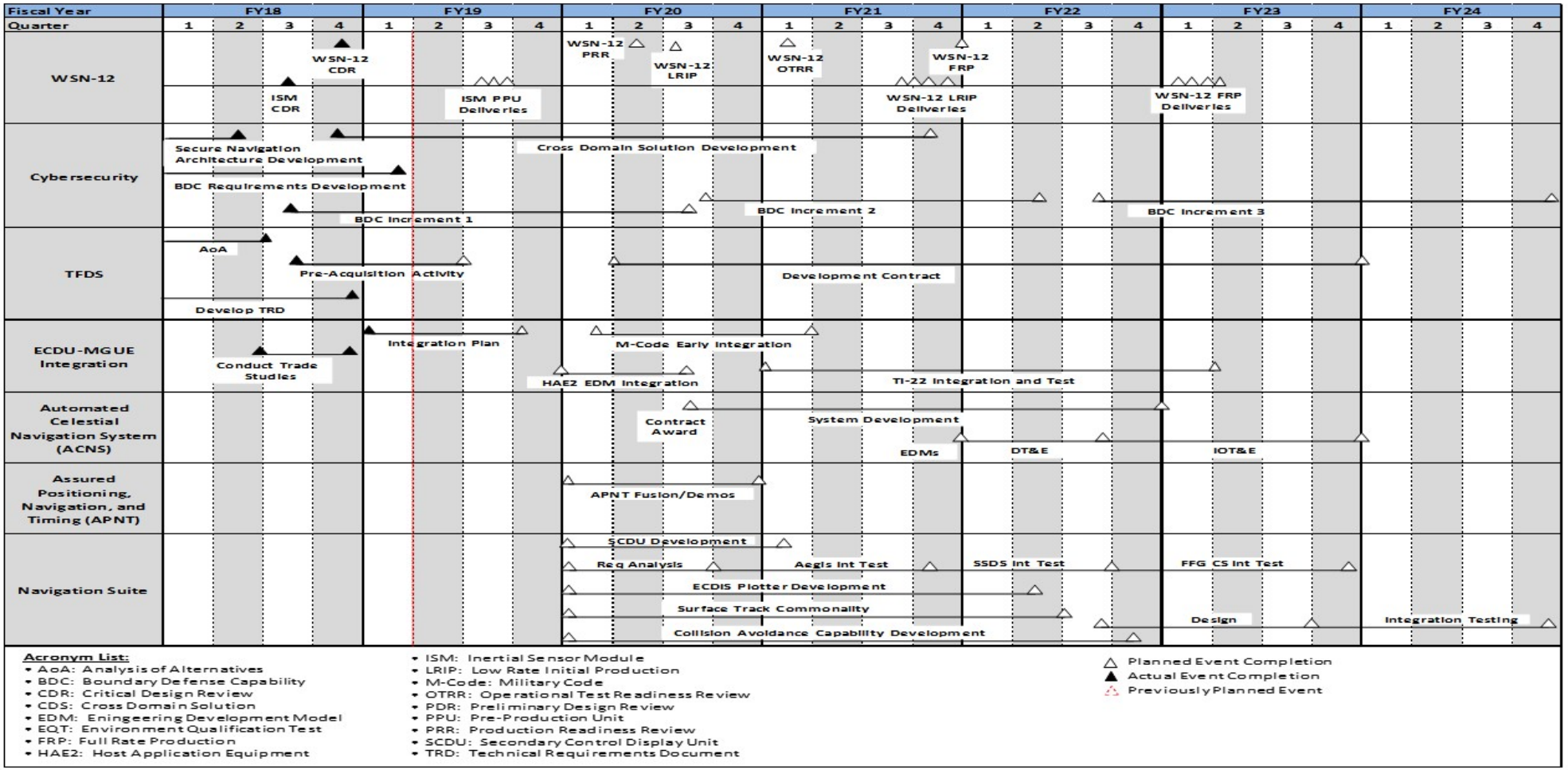

Exhibit R-4A, RDT&E Schedule Details: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Proj 3311				
ISM CDR	3	2018	3	2018
WSN-12 CDR	4	2018	4	2018
ISM PPU Deliveries	3	2019	3	2019
WSN-12 PRR	2	2019	2	2019
WSN-12 LRIP	3	2019	3	2019
WSN-12 OTRR	1	2021	1	2021
WSN-12 LRIP Deliveries	3	2021	4	2021
WSN-12 FRP	4	2021	4	2021
WSN-12 FRP Deliveries	1	2023	2	2023
Cybersecurity Secure Navigation Architecture Development	1	2018	2	2018
Cybersecurity Cross Doman Solution Development	4	2018	4	2021
Cybersecurity BDC Requirements Development	1	2018	1	2019
Cybersecurity BDC Increment 1	3	2018	3	2020
Cybersecurity BDC Increment 2	3	2020	2	2022
Cybersecurity BDC Increment 3	3	2022	4	2024
TFDS AoA	1	2018	2	2018
TFDS Develop TRD	1	2018	4	2018
TFDS Pre-Acquisition Activity	3	2018	2	2019
TFDS Development Contract	2	2020	4	2023
MGUE Trade Studies	2	2018	4	2018
MGUE Integration Plan	1	2019	4	2019
MGUE HAE2 EDM Integration	1	2020	3	2020

Exhibit R-4A, RDT&E Schedule Details: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 7	**R-1 Program Element (Number/Name)** PE 0204228N / *Surface Support*	**Project (Number/Name)** 3311 / *Navigation Systems*

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
MGUE M-Code Early Integration	1	2020	1	2021
MGUE TI-22 Integration and Test	1	2021	2	2023
ACNS System Development	3	2020	4	2022
ACNS EDM Delivery	4	2021	4	2021
ACNS DT&E	4	2021	3	2022
ACNS IOT&E	3	2022	4	2023
APNT Fusion/Demos	1	2020	4	2020
Navigation Suite SCDU Development	1	2020	1	2021
Navigation Suite Requirements Analysis	1	2020	4	2020
Navigation Suite Aegis Integration Testing	4	2020	4	2021
Navigation Suite SSDS Integration Testing	4	2021	4	2022
Navigation Suite FFG CS Integration Testing	4	2022	4	2023
Navigation Suite ECDIS Plotter Development	1	2020	2	2022
Navigation Suite Surface Track Commonality	1	2020	3	2022
Navigation Suite Collision Avoidance Capability Development	1	2020	4	2022
Navigation Suite Design	3	2022	3	2023
Navigation Integration Testing	3	2023	4	2024