Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Navy											Date: February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	53.519	64.574	34.899	-	34.899	26.488	24.970	23.135	18.166	Continuing	Continuing
2913: *Electromagnetic Systems Advanced Technology*	0.000	53.519	64.574	34.899	-	34.899	26.488	24.970	23.135	18.166	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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 2016 Navy					Date: February 2015
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	56.179	64.623	24.911	-	24.911
Current President's Budget	53.519	64.574	34.899	-	34.899
Total Adjustments	-2.660	-0.049	9.988	-	9.988
• Congressional General Reductions	-	-0.049			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.300	-			
• SBIR/STTR Transfer	-2.360	-			
• Program Adjustments	-	-	9.988	-	9.988

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy											Date: February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
2913: *Electromagnetic Systems Advanced Technology*	-	53.519	64.574	34.899	-	34.899	26.488	24.970	23.135	18.166	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Title: ELECTRONIC AND ELECTROMAGNETIC SYSTEMS	4.026	3.257	13.561	-	13.561
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 (Formerly Titled: Electronic Warfare (EW) Roadmap) - Develop classified advanced electronic warfare technology in support of current and predicted capability requirements. b) Integrated Topside (InTop): Develop wide-band array and electronic systems to support EW capability and other functions, including but not limited to IO and LOS Comms, for surface combatants with potential application to other platforms. c) Electromagnetic Maneuver Warfare Command & Control (EMC2) (FY16-FY20)- Enable a battle group to work cooperatively in the EM Spectrum (EMS) to optimize Electronic Warfare (EW), Information Operations (IO), Communications (Comms) and Radar performance. EMC2 will build upon the Resource Allocation Manager (RAM) that was previously developed for single multifunction systems under the InTop program to optimize spectrum and functional use across a platform and an entire battle group. The decrease from FY 2014 to FY 2015 is due to funds provided only in FY 2014 to accelerate the development of Integrated Topside (InTop) efforts.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Increase from FY 2015 to FY 2016 is due to: - Added new INP Electromagnetic Maneuver Warfare Command & Control (EMC2) The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2014 Accomplishments:*** Advanced EW Enabling Technologies (formerly titled: Electrontic Warfare (EW) Roadmap: - Continued development of classified advanced electronic warfare technology in support of current and predicted capability requiremente. Integrated Topside (InTop): - Initiated and completed development of GENSER IO Surrogate - Initiated and completed integration of IO Surrogate with Integrated Topside (InTop) ***FY 2015 Plans:*** Advanced EW Enabling Technologies (formerly titled: Electrontic Warfare (EW) Roadmap: - Continue all efforts of FY 2014. ***FY 2016 Base Plans:*** Advanced EW Enabling Technologies (formerly titled: Electronic Warfare (EW) Roadmap): - Continue all efforts of FY 2015. Electromagnetic Maneuver Warfare Command & Control (EMC2): - Initiate Wideband Airborne Multifunction System design - Initiate LowRIDR SubSystem build - Initiate Electromagnetic Warfare Command and Control system design ***FY 2016 OCO Plans:*** N/A					
Title: GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY	2.156	2.305	2.338	-	2.338
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Position, Navigation and Timing (PNT) capabilities using either GPS systems, non-GPS navigation devices, or atomic clocks. This activity will increase the operational effectiveness of U.S. Naval units. The focus is on the mitigation of GPS electronic threats, the development of atomic clocks that					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
possess unique long-term stability and precision, and the development of compact, low-cost, Inertial Navigation Systems (INS). The major objectives of this activity are: a) GPS Anti-Jam Antennas and Receivers - Integrate and demonstrate anti-jam antennas and antenna electronics for Navy platforms for the purpose of providing precision navigation capabilities in the presence of electronic threats; to integrate and demonstrate anti-spoofer/anti-jam processors for the purpose of providing precision navigation capabilities in the presence of emergent threats. b) Precision Time and Time Transfer - Integrate and demonstrate tactical grade atomic clocks that possess unique long-term stability and precision for the purpose of providing GPS-independent precision time; to integrate and demonstrate the capability of transferring GPS-derived time via radio frequency links for the purpose of providing GPS-independent precision time. c) Non-GPS Navigation Technology - To integrate and demonstrate inertial navigation systems for the purpose of providing an alternative means of providing precision navigation for those Naval platforms which may not have GPS navigation capabilities and/or loss of GPS signals; to integrate and demonstrate a correlation navigation technique using earth maps of high precision (including bathymetric, magnetic and gravimetric data) for navigation for those Naval platforms which may not have GPS navigation capabilities and/or loss of GPS signals. The following are non-inclusive examples for projects funded in this activity. ***FY 2014 Accomplishments:*** GPS Anti-Jam Antennas and Receivers: - Continued development of Small Antenna Based Anti-spoofing project - Continued development of Advanced Spoofer Tracking - Continued development of Next Generation Global Positioning Satellite System - Situational Awareness (XGPSS-SA) Challenged Environment. - Continued Modernized Receiver for RF Challenged Environments. - Continued development of the Simulation of GPS Signals in a Stressed Environment. - Continued development of Self Calibrating GPS AJ Antennas for Electronic Support. - Continued Cognitive Modernized GPS User Equipment (MGUE) for GPS-Denied Environments project.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Completed Application of National Airspace Air Traffic Control (ATC) Automatic Dependant Surveillance Broadcast (ADS-B) project - Initiated GPS Antenna System for Enhanced EP, ES and Precise Navigation. Precision Time and Time Transfer: - Continued development of algorithms for distributed time scaling; developed architectures necessary to establish a Navy Global Coordinated Time Scale; tested the algorithms via both simulation and using actual clock data provided by the U.S. Naval Observatory (USNO). - Continued development and Distributing Time-frequency Device. - Continued development of Rb 3-cc Tactical Grade Atomic Clock (TGAC). - Completed Ultra-Precise Timing Using GPS (UPTUG) Project. - Initiated DoD master clock time transfer via optical fibers. Non-GPS Navigation Technology: - Continued Optically Transduced MEMS Inertial Navigation System project. - Continued Sub-harmonic Lateral Mode MEMS Inertial Navigation System project. - Continued Two-Axis Gyro-compass Fiber Optic Inertial Navigation System project. - Continued development of Wavewinds project. - Continued development of Small Unmanned Underwater Vehicle - Sonar Aided Inertial Navigation Technology (UUV-SAINT) project. - Continued development of Portable PCNS project. - Continued development of Superconducting Magnetometer On-Board Navigation (SIMON) System. - Continued development of Alternative Navigation Over Unstructured or Featureless Terrain. - Completed Modernized Integrated Spoofer Tracking (MIST) Prototype. - Completed Hollow-core Fiber Optic Inertial Navigation System. - Initiated Two-Axis Fiber Optic Inertial Navigation System Phase II project. - Initiated Mechanical System (MEMS) Inertial Navigation System (INS) Phase II project. - Initiated Angle-Only Infra Red Celestial Navigation System. ***FY 2015 Plans:*** GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2014 less those noted as completed.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Precision Time and Time Transfer: - Continue all efforts of FY 2014 less those noted as completed. - Initiate Tactical Grade Atomic Clock. Non-GPS Navigation Technology: - Continue all efforts of FY 2014 less those noted as completed. - Complete Precise At-Sea Ship's Indoor Outdoor Navigation (PASSION). - Initiate Miniature Ultra-Cold Atom Chip Inertial Sensors. ***FY 2016 Base Plans:*** GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2015. - Complete Modernized Integrated Spoofer Tracking Precision Time and Time Transfer: - Continue all efforts of FY 2015. - Complete Tactical Grade Atonic Clock Non-GPS Navigation Technology: - Continue all efforts of FY 2015 less those noted as completed. - Complete Two-Axis Gyro-compass Fiber Optic Inertial Navigation System. - Complete development of Superconducting Magnetometer On-Board Navigation (SIMON) System. - Initiate Broadband Navigation Sonar (BBNS) Technology ***FY 2016 OCO Plans:*** N/A					
Title: INTEGRATED TOPSIDE (INTOP) INNOVATIVE NAVAL PROTOTYPE (INP) ***Description:*** The overarching objective of the INTOP INP is to develop and demonstrate a set of prototypes that integrate RF functionality (EW, Radar, Communications, Navigation) into a common set of multi-function apertures electronics and software through an architecture that is modular, scalable across all platforms, and open at the RF as well as computer and software level. The apertures are capable of providing multiple simultaneous, independent beams which can together perform any of the above functions.	47.337	49.869	10.000	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
The major objectives of this activity are: a) Submarine SATCOM Array - Develop wide-band SATCOM array capable of supporting EW for submarines. b) Electronic Warfare (EW)/Information Operations (IO)/Line of Sight (LOS) Communications (Comms) for Surface Combatants - Develop wide-band array to support EW capability and other functions, including but not limited to IO and LOS Comms, for surface combatants with potential application to other platforms. c) Architecture, Standards and Devices - Develop architecture and standards for wide-band multi-beam, multi-band arrays and below deck systems and the technology and electronic devices needed to make integrated array systems affordable. d) Surface Combatant Communication Array - Develop wide-band surface combatant communication array capable of supporting other RF functions. e) Resource Allocation Manager - Develop enterprise common Resource Allocation Manager. f) Digital Radar - Develop an all digital radar to demonstrate advanced concepts for coherent radar networking and control, which will increase radar coverage and provide new levels of electronic protection (EP), while maximizing radar resources and reducing cost. g) Low Band Communications, IO and EW - Develop low band technology development and concept studies leading to development of an Advanced Development Model (ADM). The increase in funding from FY 2014 to FY 2015 is to design and develop the LowRIDR to cover the bands below SEWIP Block III, to build the highly adaptable FLEXDAR Radar. The decrease between FY 2015 and FY 2016 is representative of the InTop program coming to an end. The funding provided in FY 2016 is to complete all efforts under the InTop program originally scheduled to be completed in FY 2015. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
FY 2014 Accomplishments: Submarine SATCOM Array: - Continued integration and test program. - Completed prototype build. EW/IO/Comms for Surface Combatants: - Completed development of prototype capability. - Completed development of EW/IO/Comms prototype. - Completed demonstration of technologies and subsystems for EW/IO/Comms prototype. - Initiated integration and test of ADM. Architecture, Standards and Devices: - Continued development of deckhouse and platform integration strategies and concepts. - Completed SEWIP Block III Prototype Surface Combatants Satellite Communications Array: - Continued design effort. Resource Allocation Manager: - Continued integration and test of RAM. Digital Radar: - Continued design effort. - Initiated system build for back-end. - Initiated system design for front-end. Low Band Communications, IO and EW: - Continued development of the initial architrcture and requirements. ***FY 2015 Plans:*** Submarine SATCOM Array: - Complete integration and test.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
EW/IO/Comms for Surface Combatants: - Complete integration and test of ADM. Architecture, Standards and Devices: - Complete development of deckhouse and platform integration strategies and concepts. Surface Combatants Satellite Communications Array: - Complete design effort. Resource Allocation Manager: - Continue all efforts of FY 2014 less those noted as completed above. Digital Radar: - Continue all efforts of FY 2014 less those noted as completed above. - Complete system design for front-end. - Initiate system build for front-end. Low Band Communications, IO and EW: - Continue all efforts of FY 2014 less those noted as completed above. - Complete architecture and requirements. - Initiate subsystem designs.					
FY 2016 Base Plans: Resource Allocation Manager: - Complete integration and test of RAM. Digital Radar: - Complete system build for front-end. Low Band Communications, IO and EW: - Complete subsystem designs.					
FY 2016 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
N/A					
Title: NETTED EMULATION OF MULTI-ELEMENT SIGNATURES AGAINST INTEGRATED SENSORS (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. This R2 activity was initiated in FY 2014 in PE 0602271N and expanded in FY 2015 to PE 0603271N. ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** - Initiate development and demonstration of the NEMESIS EW payloads and their integration into platforms. - Initiate application of the research supporting distributed control, coordination and networking of NEMESIS payloads and platforms. ***FY 2016 Base Plans:*** - Continue all efforts of FY 2015. ***FY 2016 OCO Plans:*** N/A	-	9.143	9.000	-	9.000
Accomplishments/Planned Programs Subtotals	53.519	64.574	34.899	-	34.899

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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*

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.