Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Navy											Date: March 2014	
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 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	73.985	97.690	107.872	-	107.872	136.737	116.073	125.258	124.068	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	0.000	73.985	97.690	107.872	-	107.872	136.737	116.073	125.258	124.068	Continuing	Continuing

The FY 2015 OCO Request will be submitted at a later date.

Note

FY 2013 funding and associated Future Naval Capability (FNC) efforts addressed in this Program Element (PE) are transferring to a new PE titled Future Naval Capabilities Applied Research (PE 0602750N). This is to enhance the visibility of the FNC Program by providing an easily navigable and consolidated overview of all 6.2 FNC investments in a single PE.

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.

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.

Also included in this PE is the Netted Emulation of Multi-Element Signatures against Integrated Sensors (NEMESIS) Innovative Naval Prototype (INP). NEMESIS technology addresses the need to generate the appearance of a realistic naval force to multiple adversarial surveillance and targeting sensors simultaneously.

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 2015 Navy					Date: March 2014
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*		
B. Program Change Summary ($ in Millions)	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO**	**FY 2015 Total**
Previous President's Budget	78.228	97.701	90.783	-	90.783
Current President's Budget	73.985	97.690	107.872	-	107.872
Total Adjustments	-4.243	-0.011	17.089	-	17.089
• Congressional General Reductions	-	-0.011			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.031	-			
• SBIR/STTR Transfer	-0.731	-			
• Program Adjustments	-	-	3.652	-	3.652
• Rate/Misc Adjustments	-	-	13.437	-	13.437
• Congressional General Reductions Adjustments	-6.543	-	-	-	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy											Date: March 2014
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 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
0000: *Electromagnetic Systems Applied Research*	-	73.985	97.690	107.872	-	107.872	136.737	116.073	125.258	124.068	Continuing	Continuing

The FY 2015 OCO Request will be submitted at a later date.

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 2013	FY 2014	FY 2015
Title: ELECTRONIC WARFARE TECHNOLOGY	45.210	47.436	64.185
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 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 current specific objectives are: a) Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: Develop sensors for the purpose of detection, localization, and identification of hostile signals of interest anywhere in the electromagnetic spectrum to provide autonomous and persistent Intelligence, Surveillance, and Reconnaissance (ISR) to forward deployed forces and detecting/identifying terrorists/hostiles and their communications networks.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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 2013	FY 2014	FY 2015
b) Components and Advanced Architectures/Signal Processing Designs: Develop components and advanced architectures/signal processing designs to ensure effective and reliable threat detection of hostile emissions in dense environments. c) Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: Develop countermeasures and techniques to defeat advanced RF guided threats to protect high value assets from advanced weapon attack, develop forward deployed jamming systems to negate advanced RF surveillance systems, and deny enemy usage of Global Positioning System (GPS) navigation. d) Countermeasures and Techniques to Defeat Advanced Electro-Optic/Infrared (EO/IR) Guided Threats: Develop countermeasures and techniques to defeat advanced EO/IR guided threats to protect high value assets from advanced weapon attack, disrupt and attack EO/IR ISR assets, and provide false/misleading information to hostile EO/IR targeting and tracking systems. e) Modeling and Simulation: Use modeling and simulation to assess the effectiveness of Electronic Attack (EA) engagements to develop an understanding of adversary threat characteristics to support countermeasures technique requirements/development and assess/predict engagement effectiveness to optimize combat system engagement resources. f) Electronic Protection from Electromagnetic Interference (EMI) and EA: Develop Electronic Protection (EP)/Electronic Counter-Countermeasures (ECCM) to prevent the disruption and denial of U.S. Naval RF and EO/IR sensors and systems from both unintentional EMI and intentional EA and permit unimpeded usage of the electromagnetic spectrum by U.S. and allied forces. g) Offboard/Unmanned Platforms - Electronic Warfare: Develop and demonstrate technologies that support the increased effectiveness of EW unmanned platforms. h) Integrated Distributed Electronic Warfare System (IDEWS) concept: Develop and demonstrate technologies that will enable the control of the electromagnetic (EM) spectrum over wide geographical areas, optimally utilizing all available off-board and on-board EW assets to provide synchronized and networked EW sensing and attack. i) Electronic Warfare (EW) Roadmap: Develop classified advanced electronic warfare technology in support of current and predicted capability requirements.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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 2013	FY 2014	FY 2015
j) Wideband Electronic Support (ES) - Sensing/Processing: Develop and demonstrate the capability of ES systems to provide wideband (1-110 gigahertz (GHz)) spectral coverage and improve naval (Navy and Marine Corps) battlespace awareness, which includes continuously monitoring this critical portion of the EMS; quickly and accurately classifying emitters and emitter functions; precisely and rapidly locating platforms, people, things, and events; and conducting accurate long-term monitoring and tracking of hostile forces. k) Wideband Electronic Attack (EA) - Components/Techniques: Develop and demonstrate the capability of EA systems to provide wideband (1-110 GHz) spectral coverage and improve naval (Navy and Marine Corps) ability to limit or deny enemy access to the EMS; provide false or misleading information to enemy C4ISR and targeting systems; and damage or degrade enemy sensing capabilities. l) Millimeter Wave (MMW) High Power Transmitters: To improve the capability of naval (Navy and Marine Corps) EA systems to deny or deceive sensors or weapons guidance systems operating in the MMW bands of the Electro-Magnetic Spectrum (EMS). m) Multispectral Semiconductor Lasers: Develop and demonstrate a semiconductor-based, multi-wavelength integrated laser source spanning multiple bands of the ultraviolet (UV), visible (VIS), near infrared (NIR), short-wave infrared (SWIR), mid-wave infrared (MWIR), and long-wave infrared (LWIR) spectrum with multiple discrete spectral line emissions. n) Continuously Tunable Multispectral Fiber/Waveguide Lasers: Develop and demonstrate a multi-wavelength integrated laser source with optical fibers/waveguides as the lasing media, spanning multiple bands of the UV, VIS, NIR, SWIR, MWIR, and LWIR spectrum with continuously tunable output emissions. o) Non-Mechanical Beam Steering: Develop non-mechanical beam steering technologies that will allow coherent energy spanning multiple bands of the ultraviolet UV, VIS, NIR, SWIR, MWIR, and LWIR spectrum to be directed in a low divergence beam with minimal or no side lobes over an angular range covering not less than 120-degrees conical (threshold) up to a complete hemisphere (objective). p) Enabling Cognitive and Adaptive Electronic Warfare: Apply adaptive and machine learning algorithms to EW. q) Technologies for High Throughput and Rapidly Programmable EW Systems: Develop enabling technologies for reconfigurable EW systems that have extremely high-volume processing capability.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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 2013	FY 2014	FY 2015
r) Emulation Environments for Adaptive and Targeted Electronic Warfare: Develop emulated RF environments or modeling and simulation (M&S) environments to enable the development, testing, and validation of advanced cognitive and targeted EW techniques and systems. Increase from FY 2014 to FY 2015 is due to: - An increased emphasis on exploratory research into advanced technologies and techniques to counter emerging threats operating in higher bands of the radio frequency spectrum and utilizing extreme spectral and temporal agility. - Added new scope to the Backfield project. This new effort under the EW Backfield project is to develop technologies to disrupt data links to pass information from hostile passive sensors to hostile engagement systems The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Accomplishments:*** Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continued technology development in the areas of Tactical Aircraft, Surface Ships, Submarines, Unmanned Aerial Vehicles (UAVs), and EW Enabling Technology. - Continued development of techniques to identify and exploit the processing vulnerability of passive location systems. - Continued development of multi-spectral imaging capability in Short Wave Infrared (SWIR), Mid-Wave Infrared (MWIR) and Long-Wave Infrared (LWIR) spectral bands using a rugged common aperture. - Continued advancing in the understanding of cognitive/software defined radios used in communications. - Continued development of algorithms/techniques to provide additional/improved maritime domain awareness from existing sensor data. - Continued progressing technology development in the area of network enabled coherent Electronic Warfare Support (ES). - Continued progressing technology development in the area of coordinated coherent EA waveforms. - Continued progressing development in cross-platform EA techniques. - Continued progressing technology development in the area of wideband cueing receivers. - Continued development of all-optical techniques for signal processing to provide multifunction RF capability. - Completed Digital Directional Correlator (DDC) effort by building and refining a more complete simulation of the correlator and determining via simulation and analysis the primary characteristics required for the system. - Completed progressing technology development to detect and defeat passive sensing systems. - Initiated development of a process to determine direction of arrival based on multipath distortion of the received emission. - Initiated development of photonic techniques for broadband electronic surveillance systems. Components and Advanced Architectures/Signal Processing Designs:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued development of RF technologies that support advances in receiver architecture, antenna performance, subsystem miniaturization, decoys and advanced signal processing. - Continued development of a novel approach to near real time active digital augmentation to improve the isolation of shipboard EW systems. - Continued progressing technology development in components and architectures for ES payloads. - Continued progressing technology development in ES adaptive signal processing. - Continued development of compact high power RF emulators. - Continued technology development in the area of wideband distributed decoys and control. - Continued technology development in the area of transmitters and EA techniques. - Continued technology development in the areas of wideband critical receiver components and wideband adaptive RF signal processing. - Completed Exploiting Non-Traditional Signals Using a Photonics Based Signal Processor effort by performing proof-of-concept demonstrations for the three main modes of operation for the spatial spectral optical materials when used for Electronics Support Measures (ESM) applications. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continued investigation of MMW technologies to support the development of off board and onboard countermeasures. - Continued technology development in the areas of wideband, high power, critical EA components, wideband EA techniques and technique generators, and millimeter wave high power transmitters. - Continued research into determining the vulnerability of modern communications systems. - Initiated development of a millimeter wave Rotman Lens-based electronic attack transmitter. - Initiated development of a countermeasures technique using a new novel approach. Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats: - Continued efforts to Detect and Deny EO/IR ISR Systems by developing passive and active detection systems using advanced Focal Plane Array (FPA)-based sensors and multi-spectral laser transmitters. - Continued efforts to Detect and Defeat Imaging IR sensors by developing laser-based countermeasures and advanced IR expendable decoys. - Continued progressing the Directed Energy Defeat of Multi-Mode Threats effort by measuring missile seeker interference effects. - Completed Multi-Wavelength Laser with Broad Spectrum Coverage effort by commencing quantum cascade (QC) and interband cascade (IC) chip design and fabrication in Band 4a. - Completed High Power LWIR QC Lasers for Shipboard Infrared Countermeasures (IRCM) effort with device design and thermal modeling tasks.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Completed Layered Multi-band Obscurant effort by commencing numerical analysis to optimize the predicted performance of potential materials for macroparticle design and fabrication. Modeling and Simulation: - Continued technology development in the area of advanced architectures for modeling and simulation of networked EW assets. Electronic Protection from EMI and EA: - Continued efforts for Electronic Protection of RF Sensors by developing passive and active techniques to adaptively process RF signals in EA denied and RF saturation environments. - Continued efforts for Electronic Protection of EO/IR Sensors by developing passive and active techniques to adaptively filter EO/IR radiation in EA denied and EO/IR saturation environments. - Initiated development of innovative high date-rate protected communications to circumvent malicious cyber-attack (Project Calliope) Offboard/Unmanned Platforms - Electronic Warfare: - Continued technology development in the area of autonomous control, high efficiency engines and EW payloads suitable for use in offboard and unmanned platforms. - Continued development of low cost precision direction finding techniques for small UAVs. Integrated Distributed Electronic Warfare System (IDEWS) concept: - Completed technology development in the area of network-enabled, coordinated and spatially distributed EW. Electronic Warfare (EW) Roadmap: - Continued development of classified, advanced, electronic warfare technology in support of current and predicted capability requirements. Wideband ES - Sensing/Processing: - Continued technology development in the areas of wideband cueing receiver concepts. - Continued development in critical receiver components that operate across the entire 1-110 GHz spectral range. - Continued technology development in wideband adaptive RF signal processing methods and techniques. Wideband EA - Components/Techniques: - Continued technology development in high power critical EA system components that operate across the entire 1-110 GHz spectral range.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued development in wideband EA techniques (waveforms) and techniques generators. - Continued technology development in transmit-to-receive isolation technologies and techniques, relevant to the spectral range of 1 to 110 GHz. Millimeter Wave (MMW) High Power Transmitters: - Continued development in transmitter systems (consisting of power amplifier(s), matching network, and radiating element) capable of achieving 4-10 kW or greater ERP for small decoy applications or capable of being combined to achieve 100 kW or greater ERP for large platform applications across the entire 18-45 GHz frequency range. Multispectral Semiconductor Lasers: - Initiated development of semiconductor-based, multi-wavelength integrated laser sources spanning multiple bands of the ultraviolet, visible, near IR, mid-wave IR, and long-wave IR. Continuously Tunable Multispectral Fiber/Waveguide Lasers: - Initiated development of multi-wavelength integrated laser sources with optical fibers/waveguides as the lasing media. Non-Mechanical Beam Steering: - Initiated development of non-mechanical beam steering technologies to allow coherent energy to span multiple bands of the EO/IR spectrum.			
FY 2014 Plans: Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2013. - Complete development of multi-spectral imaging capability in Short Wave Infrared (SWIR), Mid-Wave Infrared (MWIR) and Long-Wave Infrared (LWIR) spectral bands using a rugged common aperture. - Complete advancing in the understanding of cognitive/software defined radios used in communications. - Complete development of algorithms/techniques to provide additional/improved maritime domain awareness from existing sensor data. Components and Advanced Architectures/Signal Processing Designs: - Continue all efforts of FY 2013. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continue all efforts of FY 2013.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats: - Continue all efforts of FY 2013. Modeling and Simulation: - Continue all efforts of FY 2013. Electronic Protection from EMI and EA: - Continue all efforts of FY 2013. Offboard/Unmanned Platforms - Electronic Warfare: - Continue all efforts of FY 2013 less those noted as complete below. - Complete development of low cost precision direction finding techniques for small UAVs. Electronic Warfare (EW) Roadmap: - Continue all efforts of FY 2013. Wideband ES - Sensing/Processing: - Continue all efforts of FY 2013. Wideband EA - Components/Techniques: - Continue all efforts of FY 2013. Millimeter Wave (MMW) High Power Transmitters: - Continue all efforts of FY 2013. Multispectral Semiconductor Lasers: - Continue all efforts of FY 2013 less those noted as completed above. Continuously Tunable Multispectral Fiber/Waveguide Lasers: - Continue all efforts of FY 2013 less those noted as completed above. Non-Mechanical Beam Steering:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2013 less those noted as completed above. ***FY 2015 Plans:*** Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2014 less those noted as completed above. - Complete development of a process to determine direction of arrival based on multipath distortion of the received emission. - Complete development of all-optical techniques for signal processing to provide multifunction RF capability. Components and Advanced Architectures/Signal Processing Designs: - Continue all efforts of FY 2014 less those noted as completed above. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continue all efforts of FY 2014 less those noted as completed above. - Complete development of a millimeter wave Rotman Lens-based electronic attack transmitter. - Complete development of a countermeasures technique using a new novel approach. - Complete research into determining the vulnerability of modern communications systems. - Initiate development of advanced technologies and techniques to counter emerging threats operating in higher bands of the radio frequency spectrum. - Initiate development of advanced technologies and techniques to counter emerging threats utilizing extreme spectral and temporal agility. Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats: - Continue all efforts of FY 2014 less those noted as completed above. Modeling and Simulation: - Continue all efforts of FY 2014 less those noted as completed above. Electronic Protection from EMI and EA: - Continue all efforts of FY 2014 less those noted as completed above. Offboard/Unmanned Platforms - Electronic Warfare: - Continue all efforts of FY 2014 less those noted as completed above. Electronic Warfare (EW) Roadmap:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2014 less those noted as completed above. Wideband ES - Sensing/Processing: - Continue all efforts of FY 2014 less those noted as completed above. Wideband EA - Components/Techniques: - Continue all efforts of FY 2014 less those noted as completed above. Millimeter Wave (MMW) High Power Transmitters: - Continue all efforts of FY 2014 less those noted as completed above. Multispectral Semiconductor Lasers: - Continue all efforts of FY 2014 less those noted as completed above. Continuously Tunable Multispectral Fiber/Waveguide Lasers: - Continue all efforts of FY 2014 less those noted as completed above. Non-Mechanical Beam Steering: - Continue all efforts of FY 2014 less those noted as completed above. Enabling Cognitive and Adaptive Electronic Warfare: - Initiate technologies that develop new methods to represent real-time dynamic spectrum knowledge, sense and learn RF features and behaviors, and to reason about threat systems and the environment to form electronic attack strategies on-the-fly. Technologies for High Throughput and Rapidly Programmable EW Systems: - Initiate technologies that develop enabling technologies for reconfigurable EW systems that have extremely high-volume processing capability. Emulation Environments for Adaptive and Targeted Electronic Warfare: - Initiate technology development of emulated RF environments or modeling and simulation (M&S) environments to enable the development, testing, and validation of advanced cognitive and targeted EW techniques and systems.			
Title: EO/IR SENSOR TECHNOLOGIES	5.609	4.871	5.606

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Description: The overarching objective of this thrust is to develop technologies that enable the development of affordable, wide area, persistent surveillance optical architectures, day/night/adverse weather, adaptable, multi-mission sensor technology comprised of optical sources, detectors, and signal processing components for search, detect, track, classify, identify (ID), intent determination, and targeting applications and includes developments to protect these technologies from external interference. Also included are modeling and simulation required to support the development of these technologies. Efforts will also include the development of optical RF components, infrared technologies including lasers and focal plane arrays using narrow bandgap semiconductors. The current specific objectives are: a) Optically Based Terahertz (THz) and Millimeter Wave (MMW) Distributed Aperture Systems: 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. Funding decrease from FY 2013 to FY 2014 is associated with realignment of funds and increased emphasis in Mission Focused Autonomy research in PE 0602235N. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Accomplishments:*** Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued miniaturization and modularization of MMW imaging system components for small platform systems. - Continued progressing the integration of spectrally agile multi-band sensors into integrated system for use in persistent and time critical surveillance. - Continued progressing the processing architecture for data analysis and fusion of multi-spectral images. - Continued and completed field demonstration and testing of 77 gigahertz (GHz) passive MMW imager. The 77 GHz band will be used in place of 94 GHz for decreased cost and risk. - Initiated development of range-gated image reconstruction using optical phase conjugation. Wide Area Optical Architectures: - Continued development of mid and long wave IR focal plane arrays using graded-bandgap, Wtype-II, superlattices with much higher detectivity than state-of-the-art Mercury Cadmium Telluride (HgCdTe,MCT) FPAs. - Continued design of read-out integrated circuits for temporally adaptive focal plane arrays. - Continued development of spectrally agile visible, near-infrared, short-wave infrared and midwave infrared imaging technology. - Continued development of super-resolution techniques in WFOV MWIR sensors. Hyperspectral sensors and processing: - Continued integration of hyperspectral instruments onto test platforms. - Continued processing of hyperspectral data from a maritime environment. - Initiated effort to develop mid-wave infrared focal plane arrays using plasmonically coupled antimonide based majority carrier barrier device structures on advanced digital readouts for ultra low size, weight, and power night-time wide area surveillance. Coherent Laser Radar (LADAR): - Continued development of fiber lasers and coherent focal plane arrays suitable for LADAR applications. - Continued fabrication and modeling of silicon photonic chips for one dimensional beam steering. - Initiated effort to develop fiber-based long wave infrared agile, narrow-band and broadband laser sources for sensing and counter measure applications. Autonomous and Networked sensing: - Continued development of algorithms and processing that supports autonomous sensing for UAV platforms - Continued development of algorithms and processing that supports networked sensing over multiple sensors and/or sensor platforms.			
FY 2014 Plans: Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2013 less those noted as completed above. Wide Area Optical Architectures: - Continue all efforts of FY 2013 less those noted as completed above. Hyperspectral sensors and processing: - Continue all efforts of FY 2013 less those noted as completed above. Coherent Laser Radar (LADAR): - Continue all efforts of FY 2013 less those noted as completed above. Autonomous and Networked sensing: - Continue all efforts of FY 2013 less those noted as completed above. ***FY 2015 Plans:*** Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems: - Continue all efforts of FY 2014 less those noted as completed above. Wide Area Optical Architectures: - Continue all efforts of FY 2014 less those noted as completed above. Hyperspectral sensors and processing: - Continue all efforts of FY 2014 less those noted as completed above. Coherent Laser Radar (LADAR): - Continue all efforts of FY 2014 less those noted as completed above. - Complete fabrication and modeling of silicon photonic chips for one dimensional beam steering. Autonomous and Networked sensing: - Continue all efforts of FY 2014 less those noted as completed above.			
Title: NAVIGATION TECHNOLOGY	2.727	4.952	5.014
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			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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 current specific objectives are: a) GPS AJ Antennas and Receivers: Develop anti-jam and anti-spoofer antennas and antenna electronics for Navy platforms for the purpose of providing precision navigation capabilities in the presence of emerging electronic threats. b) Precision Time and Time Transfer Technology: Develop tactical grade atomic clocks that possess unique, long-term stability and precision for the purpose of providing GPS-independent precision time, and the capability of transferring precision time via radio frequency links precision time. c) Non-GPS Navigation Technology: Develop inertial/bathymetric/gravity navigation system 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. Funding increase from FY 2013 to FY 2014 is the result of the increased emphasis and investment in Navigation Applied Research in this PE and comparable reduction in GPS Advanced Technology Development in PE 0603271N. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Accomplishments:*** GPS Anti-Jam Antennas and Receivers: - Continued Precise at-Sea Ship System for Indoor Outdoor Navigation (PASSION) project. - Continued development of Military User Equipment Integrated Fault Analysis effort. - Continued development of Modernized User Equipment (MUE) Integrated Fault Analysis Technology. - Continued and completed Anti-tamper Investigation Support. - Continued and completed System for enhanced electronic protection, electronic support and precision navigation. - Completed Time-transfer via IEEE 1588 effort. - Initiated and completed Automatic Dependant Surveillance-Mode B (ADS-B) National Airspace Air Traffic Control (ATC) System to Naval Aviation applications. - Initiated Cognitive Modernized GPS User Equipment (MGUE) with Chaotic Timing Signals for GPS Denied Environments project.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Precision Time and Time Transfer Technology: - Continued Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project. - Continued developing Advanced-Development of a Miniature Atomic Clock. - Continued analysis of Code Distortion in Modernized GPS Signals on GPS Timing Receiver. - Continued development of Compact and Versatile Passively CEP (carrier envelope phase) Stabilized Optical Clock system. - Continued development of Micro Cold Atom Atomic Frequency Standard (CAAFS). - Initiated Ultra-Precise Timing Using GPS project. Non-GPS Navigation Technology: - Continued Optically Transduced Inertial Navigation System (INS) Sensor Suite (OPTIMUSS) project. - Continued development of the Three-Axis Resonant Fiber Optic-based Inertial Navigation System with the accuracy of 10 milli(m)-degrees per hour and the angle random walk (ARW) of 10 milli (m)-degrees per root hour. - Continued development of Micro-Electro-Mechanical System (MEMS) Gyro effort. - Continued development of Portable Precision Celestial Navigation System. - Initiated research in Alternative Image-based Navigation.			
FY 2014 Plans: GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2013 less those noted as completed above. - Complete Modernized User Equipment (MUE) Integrated Fault Analysis Technology. - Initate GPS Modernized Integrated Spoofer Tracking (MIST). Precision Time and Time Transfer Technology: - Continue all efforts of FY 2013. - Complete development of Micro Cold Atom Atomic Frequency Standard (CAAFS). - Complete Ultra-Precise Timing Using GPS project. Non-GPS Navigation Technology: - Continue all efforts of FY 2013. - Initiate Embedded Sonar Aided Inertial Navigation Technology (SAINT) project. - Initiate MEMS Inertial Navigation System Phase II project.			
FY 2015 Plans: GPS Anti-Jam Antennas and Receivers:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2014 less those noted as completed above. - Complete GPS Moderized Integrated Spoofer Tracking (MIST). Precision Time and Time Transfer Technology: - Continue all efforts of FY 2014 less those noted as completed above. - Initiate Robust Ultra-Precise Time Transfer Technology project. Non-GPS Navigation Technology: - Continue all efforts of FY 2014 less those noted as completed above. - Completed development of Portable Precision Celestial Navigation System. - Completed Alternative Image-based Navigation project. - Initiate Absolute Reference Grade Cold Atom Navigation project.			
Title: SOLID STATE ELECTRONICS	8.687	10.486	9.645
Description: The overarching objective of this activity is to develop higher performance components and subsystems for all classes of military RF systems that are based on solid state physics phenomena and are enabled by improved understanding of these phenomena, new circuit design concepts and devices, and improvements in the properties of electronic materials. An important subclass are the very high frequency (VHF), ultra-high frequency (UHF), microwave (MW), and millimeter wave (MMW) power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapon systems. Another subclass are the analog and high speed, mixed signal components that connect the electromagnetic signal environment into and out of digitally realized, specific function systems. These improved components are based on both silicon (Si) and compound semiconductors (especially the wide bandgap materials and narrow bandgap materials), low and high temperature superconductors, novel nanometer scale structures and materials. Components addressed by this activity emphasize the MMW and submillimeter wave (SMMW) regions with an increasing emphasis on devices capable of operating in the range from 50 gigahertz (GHz) to 10 terahertz (THz). The functionality of the technology developed cannot be obtained through Commercial-Off-the-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, operational and instantaneous bandwidth, weight, and size. Effort will involve understanding the properties of engineered semiconductors as they apply to quantum information science and technology. This activity also includes Anti-Tamper development of innovative techniques and technologies to deter the reverse engineering and exploitation of our military's critical technology and critical program information in order to impede technology transfer and alteration of system capability and prevent the development of countermeasures to U.S. systems. The current specific objectives are:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
a) Solid State Transistors and Devices: Develop solid state transistors and devices for high frequency analog and digital operation. b) High Efficiency, Highly Linear Amplifiers: Develop high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications. c) Superconducting Electronics: Develop components for RF systems utilizing 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 be combined into chains to deliver superior functionality in conventional system contexts, including, but not limited to, SATCOM, Electronic Warfare (EW), signal intelligence (SIGINT), and communications. d) Control, Reception, Transmission, and Processing of Signals: Develop electronics and photonics technology that provides for the control, reception, transmission and processing of signals. e) Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: Develop novel nanometer scale (feature size at 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. f) Anti-Tamper: Develope 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. Funding increase from FY 2013 to FY 2014 is due to the progression of Anti-Tamper Technology research from Basic to Applied Research. Funding decrease from FY 2014 to FY 2015 is the due to the completion of current packaging efforts and the reprioritizing of the additional work need to be pursued. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Accomplishments:*** Solid State Transistors and Devices: - Continued development of an integrated, tunable, frequency selective and low noise integrated module.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. - Continued MMW field plate GaN High Electron Mobility Transistor (HEMT) development. - Continued progressing mixed-signal GaN Monolithic Microwave Integrated Circuit (MMIC) technology development. - Continued progressing on effort to develop on-wafer, integrated enhancement/depletion mode, GaN transistors for mixed-signal applications. - Continued investigations into ultra-low noise, Group III-Nitride, transistor structures for RF and mm-wave receivers and transmitters. - Continued group III-Nitride transistor development for 1 THz circuits. - Continued effort to develop advanced graphene field-effect transistor (FET) technology for higher transistor cut-off frequency and lower power consumption in low-noise receivers. - Initiated development of discrete, channelized, Gallium Nitride Transistors for linear and low noise transmit and receive amplifiers. - Initiated development of high power density mm-wave transistor technology. - Initiated effort to develop ultra-scaled AlN/GaN transistors to enable superior RF amplifier performance in G-band applications. High Efficiency, Highly Linear Amplifiers: - Continued development of MMW AlGaN/GaN wide bandgap HEMT. - Continued development of AlGaN HEMT broadband amplifiers for electronic warfare decoys with increased power and efficiency than achieved with conventional solid state amplifiers. - Continued high-efficiency microwave GaN HEMT amplifier development. - Continued work on GaN MMW components at >44 GHz to allow for EHF SATCOM insertion and other MMW applications spanning to 95GHz. - Continued expansion of scope of the GaN MMW device program. - Continued component development in support of multifunctional electronic warfare. - Continued transition of GaN high-efficiency microwave HEMT amplifiers to radar and communications applications. - Continued development of MMW high efficiency amplifiers for satellite communications and compact high efficiency MMW sources for active denial systems. - Continued development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications. - Continued Sub-MMW GaN Device technology for communications, target identification and high speed data processing. - Continued development of GaN Monolithic Microwave Integrated Circuit (MMIC) Amplifier Technology for operation greater than (>)100 GHz. - Continued development of high efficiency GaN amplifier MMICs for 50-100 GHz operation. - Continued low-noise, high dynamic range Group-III Nitride amplifier development for W-band receivers. - Initiated development of group III-Nitride amplifiers for terahertz amplification.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiated development of high power density, high output power, solid state mm-wave amplifiers. Superconducting Electronics: - Continued development of first packaged prototype of 1 cm squared HF-UHF antenna for space limited platforms such as UAVs. - Continued development of effort to improve superconducting analog to digital converter performance by more than 2 bits as well as 2x in sample rate. - Continued development of mixed superconducting/semiconducting output circuits that allow energy efficient data transfer to room temperature at >10 Gbps per line and precision amplification of signals returned to the superconducting domain. These technologies are critical to the delivery of maximum system functionality from superconducting electronics and enable transmitter interference mitigation in wideband receivers. - Initiated research on components needed to achieve improved interference immunity. Control, Reception, and Processing of Signals: - Continued development of Gallium Nitride-based low-noise components for Interference Immune Navy Satcom receivers. - Continued investigations into low-noise, high dynamic range group-III Nitride receiver components for W-band and higher signal detection. - Initiated development of group III-Nitride terahertz receive technologies. - Initiated work on multi-THz real-time signal processing using combination of high speed electronic, photonic, and metamaterial techniques. - Initiated research into affordable digital array, interfacing technologies using low power, mixed signal approaches, wafer scale antennas, and analog photonic transmission techniques. - Initiated research into compact, broadband filter and channelizer components targeting multi-octave operation in the range from VHF to W-band. - Initiated effort to develop micro-miniature ferroelectrically active tunable acoustic wave devices for fast reconfiguration of circuits and systems operating at microwave through sub-millimeter-wave frequencies. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continued developing new research in graphene synthesis and device concepts. - Continued effort to develop the synthesis, fabrication and testing of grapheme-based electromechanical structures and devices. - Continued effort to develop the synthesis, fabrication and testing of grapheme-based electromechanical structures and devices. - Continued work on graphene based devices and circuits for low power flexible electronics. - Continued research on graphene-organic hybrid materials interfaces and device structures.			
FY 2014 Plans:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Solid State Transistors and Devices: - Continue all efforts of FY 2013. - Complete effort to develop on-wafer integrated enhancement/depletion mode GaN transistors for mixed-signal applications. - Initiate effort to develop and exploit reduced dimensionality transistors. High Efficiency, Highly Linear Amplifiers: - Continue all efforts of FY 2013. - Initiate effort to develop transmit and receive components using reduced dimensionality transistors. Superconducting Electronics: - Continue all efforts of FY 2013. - Initiate effort to develop reprogrammable superconducting digital filters capable of limiting Instantaneous Bandwidth (IBW) of output data stream from Analog-to-Digital Converter (ADC) to user defined choices and doing this with >10X lower processing latency and energy cost than possible in room temperature circuits. - Initiate effort to design of Analog-to-Digital Converters (ADC) to enhance minimum detectable signal sensitivity levels by 10 dB. Control, Reception, Transmission, and Processing of Signals: - Continue all efforts of FY 2013. - Initiate efforts to develop compact, high performance switch, filter, and high isolation device technologies for agile, broadband signal processing in cluttered environments. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Complete effort to develop the synthesis, fabrication and testing of grapheme-based electromechanical structures and devices. Anti-Tamper: - Initiate efforts to develop physically unclonable functions and high density 3D packaging technologies. - Initiate efforts to develop destruct mechanisms that do not cause collateral damage. - Initiate efforts to develop advanced sensors and coatings.			
FY 2015 Plans: Solid State Transistors and Devices: - Continue all efforts of FY 2014 less those noted as completed above. - Complete effort to develop advanced graphene field-effect transistor (FET) technology for higher transistor cut-off frequency and lower power consumption in low-noise receivers.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiate heterogeneous 2D transistor development. High Efficiency, Highly Linear Amplifiers: - Continue all efforts of FY 2014 less those noted as completed above. Superconducting Electronics: - Continue all efforts of FY 2014 less those noted as completed above. - Completed development of first packaged prototype of 1 cm squared HF-UHF antenna for space limited platforms such as UAVs. - Completed development of mixed superconducting/semiconducting output circuits that allow energy efficient data transfer to room temperature at >10 Gbps per line and precision amplification of signals returned to the superconducting domain. These technologies are critical to the delivery of maximum system functionality from superconducting electronics and enable transmitter interference mitigation in wideband receivers. - Initiate heterogeneous component technology development to enable performance enhancement of analog-digital converters and ultra-wideband receivers and transmitters. Control, Reception, Transmission, and Processing of Signals: - Continue all efforts of FY 2014 less those noted as completed above. - Initiate RF electronics and photonics development to implement wideband Simultaneous Transmit and Receive sensing and communications apertures on disadvantaged platforms. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continue all efforts of FY 2014 less those noted as completed above. - Initiate large-scale hexagonal boron nitride (hBN) synthesis as substrate for graphene and other 2D materials. Anti-Tamper: - Continue all efforts of FY 2014 less those noted as completed above.			
Title: SURVEILLANCE TECHNOLOGY	8.984	9.539	10.915
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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
The current specific objectives are: a) Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: Develop radar architectures, sensors, and software which address Ballistic Missile and Littoral requirement shortfalls including: sensitivity; clutter rejection; and flexible energy management. b) Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration and Feature Extraction: Develop algorithms, sensor hardware, and signal processing techniques for automated radar based contact mensuration and feature extraction in support of asymmetric threat classification and persistent surveillance and to address naval radar performance shortfalls caused by: man-made jamming and Electronic Counter Measures (ECM), unfavorable maritime conditions, and atmospheric and ionosphere propagation effects. 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 increase from FY 2014 to FY 2015 is due to funds being moved from 6.1 to 6.2 to address maturation with experimentation of network sensing of multiple threats with advanced jamming. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Accomplishments:*** Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continued Advanced Common Radar Architecture and mode development. - Completed development of a millimeter wave active/passive identification sensor. Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued demonstrations of advanced Non-Cooperative Target Recognition (NCTR) algorithms in congested harbor environments. - Continued development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenged environments. - Continued investigation of means of optimally combining mensuration, classification, and noncooperative target recognition of surface craft. - Continued development of a technology architecture for the Persistent Autonomous Surveillance System. - Continued development of automated controls for an airborne persistent multi-node sensor network. - Continued progressing development of algorithms and signal processing for Electronic Protection in airborne radars. - Continued progressing development of software and algorithms for multi-platform radar controls. - Initiated development of a technique to measure motion with a multi- aperture synthetic aperture radar. - Initiated development of amplitude control of radar transmit waveforms. - Initiated development of design and full-wave characterization of phased-array systems using the domain decomposition-finite element method. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continued development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment. - Continued progressing the development of technologies for a distributed, coherent surveillance network embedded in the background electromagnetic environment of a broadband wireless communication network. Small UAV Collision Avoidance/Autonomy Technology: - Continued development of research technologies and analytical algorithms for an effective and highly reliable collision avoidance system. Long Range Radio Frequency (RF) Identification (ID): - Continue studies for Long Range RFID techniques and initial hardware designees. ***FY 2014 Plans:*** Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2013 less those noted as complete above. Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2013 less those noted as complete above. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2013 less those noted as complete above. - Complete development of technologies for a distributed, coherent surveillance network embedded in the background electromagnetic environment of a broadband wireless communication network. Small UAV Collision Avoidance/Autonomy Technology: - Continue all efforts of FY 2013 less those noted as complete above. Long Range Radio Frequency (RF) Identification (ID): - Continue all efforts of FY 2013 less those noted as complete above. ***FY 2015 Plans:*** Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2014 less those noted as complete above - Initiate High Power, High Duty Factor, X-band Amplifier Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction: - Continue all efforts of FY 2014 less those noted as complete above Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2014 less those noted as complete above. - Complete development of technologies for a distributed, coherent surveillance network embedded in the background electromagnetic environment of a broadband wireless communication network. - Completed distributed network research on waveforms funded in prior year via 0601153N. - Initiate modeling and simulation of shipboard and airborne RF networked sensors to characterize their performance in a challenge environment. - Initiate field measurement to characterize coherent and non-coherent position, navigation, timing and communications requirements. Long Range Radio Frequency (RF) Identification (ID):			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2014 less those noted as complete above.			
Title: VACUUM ELECTRONICS POWER AMPLIFIERS	2.768	3.168	3.357

Description: The overarching objective of this activity is to develop millimeter wave (MMW) and sub-MMW power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. The technology developed cannot, for the most part, be obtained through commercial off the shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. Responding to strong interests from the various user communities, efforts are focused on the development of technologies for high-data-rate communications, electronic warfare and high-power radar applications at MMW and upper-MMW regime. The emphasis is placed on achieving high power at high frequency in a compact form factor. Technologies include utilization of spatially distributed electron beams in amplifiers, such as sheet electron beams and multiple-beams, and creation of simulation based design methodologies based on physics-based and geometry driven design codes.

The current specific objectives are:

a) High Power Millimeter and Upper Millimeter Wave Amplifiers: Develop science and technology for high power millimeter and upper millimeter wave amplifiers including high current density diamond cathodes, sheet and multiple electron beam formation and mode suppression techniques in overmoded structures.

b) Lithographic Fabrication Techniques: Develop lithographic fabrication techniques for upper-millimeter wave amplifiers.

c) Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: Develop accurate and computationally effective device-specific multi-dimensional models for electron beam generation, large-signal and stability analysis to simulate device performance and improve the device characteristics.

The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.

FY 2013 Accomplishments:
High Power Millimeter and Upper Millimeter Wave Amplifiers:
- Continued developing non-linear multi-frequency stability analysis of wide-band traveling wave tub amplifiers in order to extend millimeterwave output power limits to >2 kilowatts.
- Continued effort to develop a Density Modulated Electron Source.
- Continued electromagnetic modeling and cold testing of beam-wave interaction structures for W-band amplifiers having octave bandwidth.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Lithographic Fabrication Techniques: - Continued effort to develop 220 GHz millimeter-wave amplifiers employing electromagnetic structures that are microfabricated using lithographic techniques. - Initiated effort to produce a high-power (>100 W) millimeter-wave vacuum electronic amplifier at G-band using microfabrication techniques developed at NRL in conjunction with a new type of high-gain interaction circuit. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Initiated effort to develop a cascaded multiple-beam traveling wave amplifier, which is expected to provide unprecedented linear output power at millimeter wave frequencies (~30-40 GHz). ***FY 2014 Plans:*** High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2013 less those noted as complete above. - Complete developing non-linear multi-frequency stability analysis of wide-band traveling wave tub amplifiers in order to extend millimeterwave output power limits to >2 kilowatts. Lithographic Fabrication Techniques: - Continue all efforts of FY 2013 less those noted as complete above. ***FY 2015 Plans:*** High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2014 less those noted as complete above. - Complete effort to develop a Density Modulated Electron Source. - Complete electromagnetic modeling and cold testing of beam-wave interaction structures for W-band amplifiers having octave bandwidth. Lithographic Fabrication Techniques: - Continue all efforts of FY 2014 less those noted as complete above.			
Title: NETTED EMULATION OF MULTI-ELEMENT SIGNATURES AGAINST INTEGRATED SENSORS (NEMESIS) INNOVATIVE NAVAL PROTOTYPE (INP)	-	17.238	9.150
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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. Increase in FY 2014 is due to the transfer of funding from PE 0602114N and increased investment supporting NEMESIS development of EW payloads and platform integration. NEMESIS related EW payloads research was initiated in PE 0602114N in FY 2013. Funding decrease from FY2014 to FY2015 is due to the expansion of the program and the requirements and associated funding being executed from 0603271N. ***FY 2013 Accomplishments:*** N/A ***FY 2014 Plans:*** - Initiate development of the NEMESIS EW payloads and their integration into platforms. - Initiate research supporting distributed control, coordination and networking of NEMESIS payloads and platforms. ***FY 2015 Plans:*** - Continue all efforts of FY 2014 less those noted as complete above.			
Accomplishments/Planned Programs Subtotals	73.985	97.690	107.872

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

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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 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.