Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Navy										DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*				R-1 ITEM NOMENCLATURE PE 0602271N: *Electromagnetic Systems Applied Research*							
COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
Total Program Element	72.192	83.902	108.329	-	108.329	104.339	102.059	106.575	109.454	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	66.012	83.902	108.329	-	108.329	104.339	102.059	106.575	109.454	Continuing	Continuing
4027: *Naval Innovative Science and Engineering*	1.400	-	-	-	-	-	-	-	-	0.000	1.400
9999: *Congressional Adds*	4.780	-	-	-	-	-	-	-	-	0.000	4.780

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 (Feb 2009). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

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

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

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B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	69.327	83.902	80.672	-	80.672
Current President's Budget	72.192	83.902	108.329	-	108.329
Total Adjustments	2.865	-	27.657	-	27.657
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	3.636	-			
• SBIR/STTR Transfer	-1.700	-			
• Program Adjustments	-	-	27.618	-	27.618
• Section 219 Reprogramming	0.930	-	-	-	-
• Rate/Misc Adjustments	-	-	0.039	-	0.039
• Congressional General Reductions Adjustments	-0.001	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2010	FY 2011
Project: 9999: *Congressional Adds*		
Congressional Add: *Gallium Nitride (GaN) Power Technology*	1.593	-
Congressional Add: *National Initiatives for Applications of Multifunctional Materials*	1.992	-
Congressional Add: *SiC Wafer Production*	1.195	-
Congressional Add Subtotals for Project: 9999	4.780	-
Congressional Add Totals for all Projects	4.780	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
0000: *Electromagnetic Systems Applied Research*	66.012	83.902	108.329	-	108.329	104.339	102.059	106.575	109.454	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: ELECTRONIC AND ELECTROMAGNETIC SYSTEMS	20.957	30.700	36.652
Description: This R2 activity is devoted to mid-term technology development in close concert with programs of record. The products of these efforts are expected to transition at the end of their schedule into the associated program of record. These Future Naval Capability (FNC) Enabling Capabilities (EC's) span across the Electronics, EW, Radar, Communications, and other technology areas supporting Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR). This R2 activity also appears in PE 0603271N. For Enabling Capabilities (EC) receiving funding from both PE's the PE 0602271N portion is generally focused on component design and development while the funding from PE 0603271N is focused on integration and demonstration. The specific objectives of the current EC's are: a) Next Generation Airborne Electronic Attack: Develop and demonstrate advanced capability Airborne Electronic Attack (AEA) sub-systems (e.g., broadband exciters, power amplifiers, and transmit arrays) that provide Suppression of Enemy Air Defenses (SEAD), deliver Non-Kinetic Fires, counter Integrated Air Defense Systems (IADS), and provide suppression of Command, Control & Communications (C3) links and data networks. b) Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missiles (ASBM) Defense: Improve ship survivability by disrupting the terminal engagement phase of hostile anti-ship cruise and ballistic missiles, including improvements to both onboard (Enhanced Surface Electronic Warfare Improvement Program,(SEWIP)) and offboard (Nulka) radio frequency (RF) Electronic Attack systems.			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
c) Next Generation Countermeasure Technologies for Ship Missile Defense: Develop and demonstrate the fundamental technologies required to conduct next generation, persistent Electronic Warfare (EW) in support of ship, sea base, and littoral force missile defense operations in a distributed, coordinated manner across the entire battlespace. d) Long Range Detection and Tracking: Develop capability for simultaneous full volume radar coverage of contacts at long ranges and in a dense contact environment. e) Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: Develop and demonstrate electronics components technologies using wide bandgap semiconductors, mixed signal analog and digital, RF, microwave, millimeter wave and associated passive components thus enabling high efficiency transmitter element chains for arrays. f) Affordable Common Radar Architecture: Develop a common affordable, scalable, open radar architecture that provides affordable capability improvements and addresses total ownership cost challenges for 5 different radars. g) Low Cost over the Horizon Communications, Satellite Communications (SATCOM) and Line of Sight (LOS) Apertures: Develop technologies that provide the tools to implement a wideband tactical communications infrastructure. Developments will include techniques for LOS relay and routing using airborne platforms, as well as a SATCOM on-the-move capability for United States Marine Corps (USMC) tactical ground vehicles. Also included are technologies for pointing and tracking of airborne platforms, open architecture radio technologies, communications security (COMSEC), networking, and airborne apertures necessary for airborne relay and routing. Further developments include techniques for integrating multiple shipboard apertures in a limited space, cosite mitigation and the investigation of digital radio technologies that permit digitization at the aperture itself. h) SATCOM Vulnerability Mitigation: Develop technologies for mitigating SATCOM vulnerabilities using a wideband airborne and air-to-surface infrastructure. Technologies include approaches for development of ultra-low cost phased arrays and techniques for mitigating multi-path and scintillation on communications links. Architecture and application development will include surface-to-air communications in the 14-17 gigahertz (GHz) band, and air-to-air communications in the millimeter wave bands. Additionally, advanced techniques for the use of the ultra high frequency (UHF) spectrum will be developed which include beam forming techniques and alternative waveform designs that are used to support high bandwidth infrastructure establishment and control.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
i) Radar Electronic Attack Protection (REAP): Develop single platform precision passive electronic support measure (ESM) and electronic protection (EP) techniques and technology to counter hostile use of modern electronic attack (EA) self protection jammers. j) Data Exfiltration Nanosatellite Innovative Space Enabler (DENISE)(formerly known as Global Applications for Data Exfiltration(GLADEX)): Develop a nano-sat satellite bus with all its requisite structural, power, thermal, control, and separation subsystems and a nano-satellite compatible payload and ground terminal for monitoring and relay of unattended sensor data for global situational awareness. k) Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3.3: Develop integrated RF communications and RF jammer capability that addresses the electromagnetic interference (EMI) issue to enable interoperability. l) Wide Area Surgical and Persistent Surveillance (WASPS) Capabilities For Tier 2/3 UAVs: Develop and integrate enhanced capability interactive autonomous, small, lightweight EO/IR SAR, SIGINT sensors and integrate into an upgraded smaller lightweight, stabilized gimbal designed for 24/7 persistent surveillance applications. m) Submarine Survivability-Electronic Warfare: Develop and demonstrate technologies that will provide submarines an EA capability against surveillance radar systems through EW payloads integrated with submarine masts, as well as networked offboard platforms. These capabilities will improve the submarine's survivability in a hostile RF environment by providing a non-kinetic strike capability against enemy Intelligence, Surveillance and Reconnaissance (ISR) sensors The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. The increase from FY 2010 to FY 2011 is associated with the following: - Initiation of the two new Enabling Capabilities: the Radar Electronic Attack Protection (REAP) and the Data Exfiltration Nanosatellite Innovative Space Enabler (DENISE). - Additional emphasis in two ongoing Enabling Capabilities: Countermeasures Technologies (Surface Electronic Warfare Improvement Program (SEWIP)) and the SATCOM Vulnerability Mitigation. - JCREW 3.3 research effort. The increase from FY 2011 to FY 2012 is due to initiating EC programs include "Submarine Survivability - Electronic Warfare" and "Wide Area Surgical and Persistent Surveillance (WASPS) Capabilities For Tier 2/3 UAVs" and increased investment in JCREW.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
FY 2010 Accomplishments: Next Generation Airborne Electronic Attack: - Continued the development of RF technologies that support advances in receiver architecture, antenna performance, subsystem miniaturization, decoys and advanced signal processing. - Continued the Next Generation Airborne Electronic Attack (NGAEA) effort by conducting a requirements validation and technology assessment review. Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missile (ASBM) Defense: - Continued establishment of an industrial standard appropriate for the demonstration of greater than 106(>1E6) hour lifetime for RF life testing of Gallium Nitride (GaN) based Monolithic Microwave Integrated Circuits (MMICs) and devices, and began to apply this standard to state-of-the-art (SOA) MMICs and devices. - Continued the Enhanced Nulka Payload FNC effort by conducting a Transmitter and Receiver Technology Trade Space study. - Continued the Enhanced Surface Electronic Warfare Improvement Program (SEWIP) Transmitter FNC effort by conducting a Transmitter and Cooling Technology Trade Space study. Next Generation Countermeasure Technologies for Ship Missile Defense: - Initiated the Next Generation Countermeasures Technologies for Ship Missile Defense effort by development of techniques and technology for coordination of offboard surface/air EW payloads to achieve wide area protection for defense against anti-ship missiles. Long Range Detection and Tracking: - Continued demonstration of packaging techniques to provide cost reduction and affordability for modules, including component architecture, packaging, and scale of integration optimization. - Continued design and development of a X-Band Digital Array Radar (DAR). - Continued development of Maritime Classification and Identification modes for APY-6. - Continued development of full volume surveillance capability of the DAR advanced development model prototype. Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: - Continued effort on Affordable Electronically Scanned Array Technology to include electronics component technologies supporting S-band radar, X-band radar and electronic attack. Affordable Common Radar Architecture (ACRA):			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiated development of an Affordable Common Radar Architecture to improve supportability and performance of multiple legacy radars. Low Cost over the Horizon Communication, SATCOM and LOS Apertures: - Continued development of technology to provide a set of apertures (LOS, Satellite Communications) and link electronics that are suitable for broad Naval applications. - Continued development of technology to provide open, programmable core terminal components applicable to multiple platforms to include airborne applications and Marine vehicles. - Continued development of low cost satellite, airborne and shipboard apertures; demonstrate components in laboratory and realistic field environments. SATCOM Vulnerability Mitigation: - Initiated wideband infrastructure architecture design and development, development of alternative waveforms and development of advanced techniques for use of the spectrum. - Initiated development of technology components (e.g., phased arrays/apertures, cosite and fade mitigation techniques, advanced high band (14-17 GHz) signal processing radios) needed to support a wideband airborne infrastructure.			
FY 2011 Plans: Next Generation Airborne Electronic Attack: - Continue all efforts of FY 2010. Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missile (ASBM) Defense: - Continue all efforts of FY 2010. - Initiate redesign and fabrication of a new cooling method due to an increase in the junction temperature from DARPA's Government Furnished Equipment (GFE) amplifier. - Initiate redesign and fabrication of a new amplifier mounting design which is required to accommodate the reduction of amplifier temperatures. Next Generation Countermeasure Technologies for Ship Missile Defense: - Continue all efforts of FY 2010. Long Range Detection and Tracking: - Continue all efforts of FY 2010.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: - Continue all efforts of FY 2010. Affordable Common Radar Architecture (ACRA): - Continue all efforts of FY 2010. Low Cost over the Horizon Communication, SATCOM and LOS Apertures: - Complete all efforts of FY 2010. SATCOM Vulnerability Mitigation: - Continue ramp up of all architecture development efforts, and multi-year development efforts for waveforms and technology components cited above which were initiated in FY 2010. Radar Electronic Attack Protection (REAP): - Initiate a Network "Sentric" Electronic Protection (EP) capability by developing hardware, software and algorithms to achieve a multi-platform networked EP. - Initiate the Identification and Defeat of Electronic Attack Systems (IDEAS) FNC effort by developing single platform precision passive electronic support measure (ESM) and EP techniques and technology to counter hostile use of modern electronic attack self protection jammers. Data Exfiltration Nanosatellite Innovative Space Enabler (DENISE): - Initiate the development of a spacecraft bus structure, thermal, power, control, and command/telemetry systems for 3-axis, maneuverable, 30cm cube, 10kg, 10watt orbital average nano-satellite. - Initiate the development of launch dispensing separation mechanisms. - Initiate the development of a multi-function Data-Ex payload and ground terminal for reception of low rate (<9600 bits/sec) VHF - UHF transmissions. Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3.3: - Initiate JCREW 3.3 architecture analysis and design. - Initiate JCREW 3.3 component development. ***FY 2012 Plans:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Next Generation Airborne Electronic Attack: - Complete all efforts of FY 2011. Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missile (ASBM) Defense: - Continue all efforts of FY 2011. - Complete the Enhanced Nulka Payload FNC effort. Next Generation Countermeasure Technologies for Ship Missile Defense: - Continue all efforts of FY 2011. Long Range Detection and Tracking: - Complete demonstration of full volume surveillance capability of the DAR advanced development model prototype Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: - Continue all efforts of FY 2011. Affordable Common Radar Architecture (ACRA): - Continue all efforts of FY 2011 less those noted as completed above. SATCOM Vulnerability Mitigation: - Continue all efforts of FY 2011. Radar Electronic Attack Protection (REAP): - Continue all efforts of FY 2011. Data Exfiltration Nanosatellite Innovative Space Enabler (DENISE): - Continue all efforts of FY 2011. Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3.3: - Complete JCREW 3.3 architecture analysis and design and component development. - Initiate the Distributed Counter-RCIED FNC effort through algorithm development and assessment. - Initiate the Integrated Counter-RCIED EW (ICEW) FNC effort by starting component design and integration plans.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Wide Area Surgical and Persistent Surveillance (WASPS) Capabilities For Tier 2/3 UAVs: - Initiate the development and integration of enhanced capability interactive autonomous, small, lightweight EO/IR SAR, SIGINT sensors and integrate into an upgraded smaller lightweight, stabilized gimbal designed for 24/7 persistent surveillance applications. Submarine Survivability-Electronic Warfare: - Initiate the Coherent Electronic Attack for Submarines (CEAS) FNC effort by commencing development of the compact EA payload and techniques for the multi-mission mast (MMM). - Initiate the Distributed Coherent Electronic Attack for Submarines (D-CEAS) FNC effort by commencing an assessment of current capabilities.			
Title: ELECTRONIC WARFARE TECHNOLOGY	17.048	23.311	37.212
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. 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:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
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) Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW): Develop and demonstrate technologies to improve virtually all aspects of performance related to next generation JCREW equipment. h) Offboard/Unmanned Platforms - Electronic Warfare: Develop and demonstrate technologies that support the increased effectiveness of EW unmanned platforms. i) 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. j) Electronic Warfare (EW) Roadmap: Develop classified advanced electronic warfare technology in support of current and predicted capability requirements.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. The increase from FY 2010 to FY 2011 is due to initiation of research to develop Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats. The increase from FY 2011 to FY 2012 is due to increased emphasis and priority in research supporting the Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest, and Components and Advanced Architectures/ Signal Processing Designs research objectives. ***FY 2010 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 the development of techniques to identify and exploit the processing vulnerability of passive location systems. - Continued the development of techniques to identify and exploit the processing vulnerability of passive location systems. Transferred from PE 0602271N Supporting Technologies. - Continued the 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 the DDC effort capable of detecting, identifying, and measuring the directional azimuth and elevation of all RF emitters (including frequency hoppers) within a 360 degree field of view in a single circular sweep. Components and Advanced Architectures/Signal Processing Designs: - 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 the 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. - Completed the Miniature 2-70 GHz Integrated Optical Channelizer (IOC) effort by fabricating and demonstrating the second generation IOC.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed the Exploiting Non-Traditional Signals Using a Photonics Based Signal Processor effort that will rapidly and accurately detect and identify non-traditional RF signals including spread spectrum, frequency hopping, noise-like waveforms, and unintentional RF emissions. - Completed the Cueing Receiver for Faster EA Response Management effort by integrating the receiver into the Naval Post Graduate School's photonic, single-bit 1st order sigma-delta digital antenna to test and evaluate the new architecture's ability to digitize wideband signals directly at the antenna. - Completed the Antennas from VHF to THz effort by testing the final combo antenna from 0.03-110 GHz. - Initiated the Direction Finding of Low Probability of Intercept (LPI) Emitters effort by commencing digital algorithm development. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continued the investigation of Millimeter Wave (MMW) technologies to support the development of off board and onboard countermeasures. - Completed the development to assess the electronic protection capability of modern missiles using advanced processing and investigate the improvements needed to restore countermeasures effectiveness. Transferred from PE 0602271N Supporting Technologies. - Initiated the Concurrent Multi-Spectral RF Carrier Generator effort to develop a single-chip, low power multi-spectral RF jamming sub-system that has programmable and automatic random mode switching and nanosecond frequency hopping over 1-18 GHz. Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats: - Initiated 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. - Initiated efforts to Detect and Defeat Imaging IR sensors by developing laser-based countermeasures and advanced IR expendable decoys. Modeling and Simulation: - Completed the EW Tactical Decision Algorithms (TDA) for Satellite Communications effort by evaluating two atmospheric propagation models to assist in visualizing the impact of satellite communications on future planning and tactics. - Initiated the Real-Time EA Effectiveness Monitoring effort to assess the effectiveness in real-time of jamming an RF guided missile by exploiting the missile's RF transmission characteristics. - Initiated the Integrated Onboard/Offboard EA Effectiveness effort by starting investigation with offboard decoy waveforms and structured ship targets. Electronic Protection from EMI and EA:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiated 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. - Initiated 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. ***FY 2011 Plans:*** Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2010 less those noted as completed above. Components and Advanced Architectures/Signal Processing Designs: - Continue all efforts of FY 2010 less those noted as completed above. - Complete the Direction Finding of LPI Emitters effort by conducting field testing Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continue all efforts of FY 2010 less those noted as completed above. - Complete the Concurrent Multi-Spectral RF Carrier Generator effort by fabricating and testing an RF carrier generator with the capability of generating up to 5 simultaneous asynchronous frequencies and controlled chaotic waveforms within 1-18GHz. Countermeasures and Techniques to Defeat Advanced EO/IR Guided Threats: - Continue all efforts of FY 2010. - Initiate the Multi-Wavelength Laser with Broad Spectrum Coverage effort by commencing quantum cascade (QC) and interband cascade (IC) chip design and fabrication in Band 4a. - Initiate the High Power Long Wave Infrared (LWIR) QC Lasers for Shipboard Infrared Countermeasures (IRCM) effort with device design and thermal modeling tasks. - Initiate the Layered Multi-band Obscurant effort by commencing numerical analysis to optimize the predicted performance of potential materials for macroparticle design and fabrication. - Initiate the Directed Energy Defeat of Multi-Mode Threats effort by measuring missile seeker interference effects. Modeling and Simulation: - Complete all efforts of FY 2010. Electronic Protection from EMI and EA:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continue all efforts of FY 2010. ***FY 2012 Plans:*** Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2011. - Initiate technology development in the area of network enabled coherent Electronic Warfare Support (ES). - Initiate technology development to detect and defeat passive sensing systems. - Initiate technology development in the area of coordinated coherent EA waveforms. - Initiate development in cross-platform EA techniques. - Initiate technology development in the area of wideband cueing receivers. Components and Advanced Architectures/Signal Processing Designs: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate technology development in components and architectures for ES payloads. - Initiate technology development in ES adaptive signal processing. - Initiate development in compact high power RF emulators. - Initiate technology development in the area of wideband distributed decoys and control. - Initiate technology development in the area of transmitters and EA techniques. - Initiate technology development in the areas of wideband critical receiver components and wideband adaptive RF signal processing. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate technology development in the areas of wideband high power critical EA components, wideband EA techniques and technique generators, and millimeter wave high power transmitters. Countermeasures and techniques to Defeat Advanced EO?IR Guided Threats: - Continue all efforts of FY 2011 Modeling and Simulation: - Initiate technology development in the area of advanced architectures for modeling and simulation of networked EW assets. Electronic Protection from EMI and EA:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continue all efforts of FY 2011. - Initiate technology development in the area of advanced architectures for modeling and simulation of networked EW assets. Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW): - Initiate development of technologies to improve capabilities and effectiveness of JCREW equipment. Offboard/Unmanned Platforms - Electronic Warfare: - Initiate technology development in the area of autonomous control, high efficiency engines and EW payloads suitable for use in offboard and unmanned platforms. Integrated Distributed Electronic Warfare System (IDEWS) concept: - Initiate technology development in the area of networked-enabled coordinated and spatially distributed EW. Electronic Warfare (EW) Roadmap: - Initiate development of classified advanced electronic warfare technology in support of current and predicted capability requirements.			
Title: EO/IR SENSOR TECHNOLOGIES	7.053	7.324	5.888
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 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
c) High Power Laser Sources: Develop high power laser sources for countermeasure and active imaging applications. d) Dynamic, Adaptable Wide Field-of-View (WFOV)/Narrow Field-of-View (NFOV) Surveillance and Sensor Technology: Develop dynamic, adaptable WFOV/NFOV surveillance and sensor technology for airborne surveillance, identification, and targeting applications. e) Non-cryogenically Cooled Infrared Photon Detectors: Develop non-cryogenically cooled infrared photon detectors for compact sensors on severely power constrained platforms. f) UAV Deployable Infrared (IR) Sensor Payloads: Develop UAV deployable EO/IR sensor payloads for persistent surveillance missions. g) 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. h) Coherent Laser Radar (LADAR): Develop and improve components for LADAR applications including fiber lasers, coherent focal planes, and advanced processing. i) Autonomous and Networked sensing: Develop algorithms and processing that supports autonomous sensing for UAV platforms and that supports networked sensing over multiple sensors and/or sensor platforms. The decrease from FY 2011 to FY 2012 is associated with reduced efforts in EO/IR Sensor Technologies. In FY 2010, research formerly funded and justified in the Navigation, EO/IR and Sensor Technologies Activity in PE 0602114N is being consolidated into this PE. Funding levels associated with the consolidated efforts are consistent with prior year totals. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2010 Accomplishments:*** Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued to perform field demonstration and testing of 94 gigahertz (GHz) passive millimeter wave (MMW) imager. Transferred from PE 0602114N. - Continued the development of techniques to combine current EO/IR technology and recent findings on the characteristics of the eye to classify and identify optical devices and individuals in real time at militarily significant ranges. Transferred from PE 0602114N. - Continued the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenging environments. Transferred from PE 0602114N. - Completed the development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment. Transferred from PE 0602114N. - Completed the development of an active optics system that can survey a wide area and instantly, nonmechanically zoom-in on an area of interest for target tracking/identification. Transferred from PE 0602114N. - Initiated miniaturization and modularization of MMW imaging system components for small platform systems. Wide Area Optical Architectures: - Continued development of ultra-high-sensitivity detectors suitable for use in focal plane arrays (FPAs) for the Shortwave Infrared (SWIR) spectral band. Transferred from PE 0602114N. - 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. Transferred from PE 0602114N. - Completed field and flight testing of foveated zoom imager. Transferred from PE 0602114N - Completed system integration and test of optically agile zoom imager. Transferred from PE 0602114N. - Initiated design of read-out integrated circuits for temporally adaptive focal plane arrays. - Initiated development of spectrally agile visible, near-infrared, short-wave infrared and midwave infrared imaging technology. - Initiated integration of optically and temporally adaptable imaging technologies into sensor for networked persistent surveillance system. High Power Laser Sources: - Completed development of high power fiber lasers in MWIR (2-5 1/4m) based upon highly nonlinear IR transmitting chalcogenide photonic crystal fibers. Transferred from PE 0602114N.			
FY 2011 Plans: Optically Based Terahertz (THz) and Millimeter Wave Distributed Aperture Systems: - Continue all efforts of FY 2010 less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Complete demonstration and testing of 94 GHz passive MMW imaging system. - Complete the development of techniques to combine current EO/IR technology and recent findings on the characteristics of the eye to classify and identify optical devices and individuals in real time at militarily significant ranges. - Complete the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenging environments. - Initiate integration of spectrally agile multi-band sensors into integrated system for use in persistent and time critical surveillance. - Initiate processing architecture for data analysis and fusion of multi-spectral images. Wide Area Optical Architectures: - Continue all efforts of FY 2010 less those noted as completed above. - Complete effort to develop ultra-high-sensitivity detectors suitable for use in focal plane arrays (FPAs) for the short-wave infrared (SWIR) spectral band. Transferred from PE 0602114N. - Complete integration of optically and temporally adaptable imaging technologies into sensor for networked persistent surveillance system.			
FY 2012 Plans: Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems: - Continue all efforts of FY 2011 less those noted as completed above. - Complete field demonstration and testing of 77 gigahertz (GHz) passive millimeter wave (MMW) imager. The 77 GHz band will be used in place of 94 GHz for decreased cost and risk. Wide Area Optical Architectures: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate the development of super-resolution techniques in WFOV MWIR sensors. Hyperspectral sensors and processing: - Initiate integration of hyperspectral instruments onto test platforms. - Initiate the processing of hyperspectral data from a maritime environment. Coherent Laser Radar (LADAR): - Initiate the development of fiber lasers and coherent focal plane arrays suitable for LADAR applications.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Autonomous and Networked sensing: - Initiate the development of algorithms and processing that supports autonomous sensing for UAV platforms - Initiate the development of algorithms and processing that supports networked sensing over multiple sensors and/or sensor platforms.			
Title: NAVIGATION TECHNOLOGY	3.617	2.835	2.889
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Position, Navigation and Timing (PNT) capabilities using the GPS, non-GPS navigation devices, and atomic clocks. This project will increase the operational effectiveness of U.S. Naval units. Emphasis is placed on GPS Anti-Jam (AJ) Technology; Precision Time and Time Transfer Technology; and Non-GPS Navigation Technology (Inertial aviation system, bathymetry, gravity and magnetic navigation). The focus is on the mitigation of GPS electronic threats, the development of atomic clocks that possess unique long-term stability and precision, and the development of compact, low-cost Inertial Navigation Systems (INS). The 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. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2010 Accomplishments:*** GPS Anti-Jam Antennas and Receivers: - Continued the development of GPS AJ Antenna Electronics (AE) with low-cost analog processor			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
technique for Direction of Arrival (DOA) estimation and nulling (up to 60dB nulling capability). - Continued the development of Space-Frequency Adaptive Processing (SFAP) for GPS Anti-Spoofer using the existing Code Gated Maximum Likelihood (CGML) receiver. - Continued the GPS Dual Receiver Hot Start Acquisition (DRHSA) project. - Continued the GPS Threat Assessment project. - Continued the Multi-Frequency Continuously Operating GPS Anomalous Event Monitor (GAEM) project. - Continued the Precise at-Sea Ship System for Indoor Outdoor Navigation (PASSION) project. Precision Time and Time Transfer Technology: - Continued the Self-Locked Intra-Cavity Alkali Vapor Laser (ICAL) Opto-Atomic Clock project. - Continued the Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project. Non-GPS Navigation Technology: - Continued the Deeply Integrated Navigation Grade GPS Inertial System project. - Continued the Micro Fiber Optical Gyro (MFOG) project. - Continued the Ship's Passive Inertial Navigation System (SPINS) project. - Continued the Sonar Aided Inertial Navigation Technology (SAINT) project. - continued the Optically Transduced Inertial Navigation System (INS) Sensor Suite (OPTIMUSS) project. - Initiated 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. - Initiated development of the SAINT system for littoral application; the SAINT will be applied to the existing Precision Underwater Mapping (PUMA) device.			
FY 2011 Plans: GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2010. - Complete GPS AJ Antenna Electronics effort. - Complete the SFAP for GPS Anti-Spoofer using the CGML receiver effort. - Complete the DRHSA project. - Initiate Time-transfer via IEEE 1588 effort. - Initiate Military User Equipment Integrated Fault Analysis effort.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Precision Time and Time Transfer Technology: - Continue all efforts of FY 2010. - Complete the ICAL Opto-Atomic Clock project. - Initiate Advanced-Development of a Miniature Atomic Clock. Non-GPS Navigation Technology: - Continue all efforts of FY 2010. - Complete Deeply-Integrated GPS-INS project. - Complete MFOG project. - Complete SPINS project. - Complete SAINT project. - Complete SAINT-PUMA application. - Initiate Micro-Electro-Mechanical System (MEMS) Gyro effort.			
FY 2012 Plans: GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2011 less those noted as completed above. - Complete Time-transfer via IEEE 1588 effort. - Initiate MUE Integrated Fault Analysis Technology. - Initiate Anti-tamper Investigation Support. - Initiate System for enhanced electronic protection, electronic support and precision navigation. Precision Time and Time Transfer Technology: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate Effects of Code Distortion in Modernized GPS Signals on GPS Timing Receiver. - Initiate Compact and versatile passively CEP (carrier envelope phase)-stabilized optical clock system. - Initiate Micro cold atom atomic frequency standard (CAAFS). Non-GPS Navigation Technology: - Continue all efforts of FY 2011 less those noted as completed above. - Complete Micro-Electro-Mechanical System (MEMS) Gyro effort. - Initiate Portable Precision Celestial Navigation System.			
Title: SOLID STATE ELECTRONICS	7.125	8.149	9.128

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
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 weapons 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 sdterahertz (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. The current specific objectives are: 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, and Processing of Signals: Develop electronics technology that provides for the control, reception, and processing of signals.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
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. The increase from FY 2011 to FY 2012 is due to emphasis in Solid State Electronics research in response to naval need. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. In FY 2010, efforts from Supporting Technologies and Solid State Power Amplifiers are being consolidated into this new activity to provide improved fidelity of efforts. ***FY 2010 Accomplishments:*** Solid State Transistors and Devices: - Continued development of Antimony (Sb)-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. - Continued development of an integrated tunable frequency selective and low noise integrated module. - Continued effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. - Continued MMW field plate GaN High Electron Mobility Transistor (HEMT) development. 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 the 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed high efficiency S-Band GaN HEMT amplifier development. Superconducting Electronics: - Continued development of a second generation superconducting digital channelizer which includes a 1xk multiplier. - Continued demonstration of an improved signal processing technique that can be applied to state-ofthe-art L, S, X, and Ka-band superconducting bandpass ADCs to realize an improvement in dynamic range of greater than 6dB. - Completed proof of concept demonstration of a wideband, high dynamic range combined LNA and antenna, based on arrays of superconducting quantum interference devices (SQUIDs) on a 1 centimeter squared (cm2) chip for frequencies below 200 megahertz (MHz). Control, Reception, and Processing of Signals: - Continued development of an integrated tunable frequency selective and low noise integrated module. - Continued development of Gallium Nitride-based low-noise components for Interference Immune Navy Satcom receivers. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Completed development of Cellular Nonlinear Network (CNN) processing techniques for unmanned air vehicle (UAV)landing applications. - Continued effort to develop a highly linear, low-noise RF amplifier using aligned arrays of single-walled carbon nanotubes. - Continued development of three dimensional (3D)-integrated CNN image sensing processing architecture research. ***FY 2011 Plans:*** Solid State Transistors and Devices: - Continue all efforts of FY 2010. - Initiate mixed-signal GaN Monolithic Microwave Integrated Circuit (MMIC) technology development. High Efficiency, Highly Linear Amplifiers: - Continue all efforts of FY 2010 less those noted as completed above. - Initiate development of GaN Monolithic Microwave Integrated Circuit (MMIC) Amplifier Technology for operation greater than (>)100 GHz. - Initiate development of high efficiency GaN amplifier MMICs for 50-100 GHz operation. Superconducting Electronics: - Complete development of a second generation superconducting digital channelizer which includes a 1xk multiplier.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Complete demonstration of an improved signal processing technique that can be applied to state-of-the-art L, S, X, and Ka-band superconducting bandpass ADCs to realize an improvement in dynamic range of greater than 6dB. - Initiate development of first packaged prototype of 1 cm squared HF-UHF antenna for space limited platforms such as UAVs. - Initiate effort to improve superconducting analog to digital converter performance by more than 2 bits as well as 2x in sample rate.. Control, Reception, and Processing of Signals: - Continue all efforts of FY 2010. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continue all efforts of FY 2010 less those noted as completed above. - Complete development of three dimensional (3D)-integrated CNN image sensing processing architecture research. - Initiate new research in graphene synthesis and device concepts. ***FY 2012 Plans:*** Solid State Transistors and Devices: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate investigations into ultra-low noise Group III-Nitride transistor structures for RF and mm-wave receivers and transmitters. - Initiate group III-Nitride transistor development for 1 THz circuits High Efficiency, Highly Linear Amplifiers: - Continue all efforts of FY 2011. - Initiate low-noise, high dynamic range Group-III Nitride amplifier development for W-band receivers Superconducting Electronics: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate 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. Control, Reception, and Processing of Signals: - Continue all efforts of FY 2011.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate investigations into low-noise, high dynamic range group-III Nitride receiver components for W-band and higher signal detection Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Continue all efforts of FY 2011 less those noted as completed above. - Initiate work on graphene based devices and circuits for low power flexible electronics. - Initiate research on graphene-organic hybrid materials interfaces and device structures.			
Title: SPECTRUM SHARING ***Description:*** Research in this activity addresses the need to develop innovate new and improved methods and technologies for management of the RF Spectrum to compensate for decreased RF Spectrum frequencies reserved for military use and increasing demand from Navy sensor and communications systems. Navy platforms rely on the RF Spectrum for both sensing and communication capabilities. Efficient sharing of the RF Spectrum requires the development of new concepts and technologies to manage spectrum demands. Spectrum Sharing will develop concepts and technologies that will optimize spectrum management and sharing across within individual systems, platforms, and across the battlegroup. ***FY 2012 Plans:*** Initiate research for RF Spectrum Management for Navy communications and sensor systems and platforms. This effort is classified.	-	-	3.300
Title: SURVEILLANCE TECHNOLOGY ***Description:*** The overarching objective of this activity is to develop advanced sensor and sensor processing systems for continuous high volume theater-wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection and discrimination, target identification (ID) and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments and includes modeling and simulation required to support the development of these technologies. The current specific objectives are: a) Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: Develop radar architectures, sensors, and software which address Ballistic Missile and Littoral requirement shortfalls including: sensitivity; clutter rejection; and flexible energy management. b) Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration and Feature Extraction: Develop algorithms, sensor hardware, and signal processing techniques for automated radar based contact	6.980	8.170	9.434

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012

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).

Increase from FY 2011 to FY 2012 is due to emphasis in Surveillance Technology research in response to naval need.

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

FY 2010 Accomplishments:
Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls:
- Continued the Horizon Extension Sensor System (HESS) project with form factored integration of High Power Amplifier (HPA) and development of a Silicon Germanium (SiGe) downconverter in support of HESS and Digital Array Radar (DAR) efforts.
- Continued an element level DAR effort on down conversion and digital beam formers.
- Continued the requirements analysis and trade studies of an Advanced Common Radar Architecture.
- Initiated 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:
- Continued development efforts to demonstrate signal processing, waveform generation and one dimensional active phased array apertures for harbor surveillance and situational awareness.
- Continued demonstrations of advanced Non-Cooperative Target Recognition (NCTR) algorithms in congested harbor environments.
- Continued the assessment of vulnerabilities of modern side lobe canceling (SLC) algorithms to adversary jamming and develop mitigating SLC design improvements.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602271N: *Electromagnetic Systems Applied Research*	PROJECT 0000: *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued the 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. - Completed the assessment of vulnerabilities of modern side lobe canceling (SLC) algorithms to adversary jamming and develop mitigating SLC design improvements. - Initiated development of a technology architecture for the Persistent Autonomous Surveillance System. - Initiated development of automated controls for an airborne persistent multi-node sensor network. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continued the development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment. Small UAV Collision Avoidance/Autonomy Technology: - Continued development of research technologies and analytical algorithms for an effective and highly reliable collision avoidance system.			
FY 2011 Plans: Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2010. Algorithms, Sensor Hardware, and Signal Processing Techniques For Automated Radar Based Contact Mensuration And Feature Extraction: - Continue all efforts of FY 2010 less those noted as completed above. - Initiate development of algorithms and signal processing for Electronic Protection in airborne radars. - Initiate development of software and algorithms for multi-platform radar controls. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2010. Small UAV Collision Avoidance/Autonomy Technology:			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602271N: *Electromagnetic Systems Applied Research*	PROJECT 0000: *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continue all efforts of FY 2010. ***FY 2012 Plans:*** Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2011, less those noted as completed above. - Complete the Horizon Extension Sensor System (HESS) project with form factored integration of High Power Amplifier (HPA) and development of a Silicon Germanium (SiGe) downconverter in support of HESS and Digital Array Radar (DAR) efforts. - Complete an element level DAR effort on down conversion and digital beam formers. - Complete the requirements analysis and trade studies of an Advanced Common Radar Architecture. - Initiate Advanced Common Radar Architecture, and mode development. Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration And Feature Extraction: - Continue all efforts of FY 2011, less those noted as completed above. - Complete development efforts to demonstrate signal processing, waveform generation and one dimensional active phased array apertures for harbor surveillance and situational awareness. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2011. Small UAV Collision Avoidance/Autonomy Technology: - Continue all efforts of FY 2011. Long Range Radio Frequency (RF) Identification (ID): - Initiate studies for Long Range RFID techniques and initial hardware designes.			
Title: VACUUM ELECTRONICS POWER AMPLIFIERS ***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	3.232	3.413	3.826

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012

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 increase from FY 2011 to FY 2012 is due to expanded effort in Vacuum Electronics Power Amplifiers research.

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

FY 2010 Accomplishments:

High Power Millimeter and Upper Millimeter Wave Amplifiers:
- Continued the development of high-current-density cathodes based on diamond current amplifier.
- Continued effort to produce a compact, high-power, W-band amplifier by developing an extended interaction klystron circuit that will be mated to a novel sheet-beam gun, permanent magnet & collector.
- Continued the development of new spatially-distributed electron beam traveling-wave amplifier structures incorporating novel mode suppression techniques.

Lithographic Fabrication Techniques:
- Continued effort to develop 220 GHz millimeter-wave amplifiers employing electromagnetic structures that are microfabricated using lithographic techniques.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Continued effort on the gun/collector code MICHELLE with improved interface with the large signal codes CHRISTINE and Telegrapher's Equation Solution for Linear Amplifiers (TESLA). - Continued the effort on developing algorithms and models in large signal code TESLA for multiple beam klystrons. - Continued the effort on the development and implementation of models and algorithms in a large signal klystron code to model sheet electron beam - wave interaction. - Continued the effort on developing models and algorithms based on generalized model expansion (GENOME) techniques for large signal modeling of extended interaction klystrons (EIK). - Continued the effort on the development and implementation of models and algorithms in a large signal TWT code to model sheet electron beam - wave interaction. - Completed nonlinear stability analysis for the broadband coupled cavity - traveling wave tube (CC-TWT). - Completed an end-to-end analysis of a Helix traveling wave tube (TWT). using the large signal CHRISTINE 3D code. - Initiated development of coupled-cavity 2D algorithms in TESLA for the CC-TWT.			
FY 2011 Plans: High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2010. Lithographic Fabrication Techniques: - Continue all efforts of FY 2010. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Continue all efforts of FY 2010 less those noted as completed above. - Complete effort on the gun/collector code MICHELLE with improved interface with the large signal codes CHRISTINE for helix TWT's and TESLA for klystrons. - Initiate development of parallel version of MICHELLE for gun/collector code to reduce computational time by factor of 10 for realistic 3D electron beams. - Initiate effort in the development of stability analysis for broadband extended interaction klystrons.			
FY 2012 Plans: High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2011 .			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Lithographic Fabrication Techniques: - Continue all efforts of FY 2011. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Continue all efforts of FY 2011 less those noted as complete above.			
Accomplishments/Planned Programs Subtotals	66.012	83.902	108.329

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• 0603271N: *ELECTROMAGNETIC SYSTEMS ADVANCED TECHNOLOGY*	19.594	24.586	31.782	0.000	31.782	39.723	29.845	24.876	6.109	0.000	176.515

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

This PE supports the development of technologies that 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. 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.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602271N: *Electromagnetic Systems Applied Research*	PROJECT 4027: *Naval Innovative Science and Engineering*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
4027: *Naval Innovative Science and Engineering*	1.400	-	-	-	-	-	-	-	-	0.000	1.400

A. Mission Description and Budget Item Justification

Funding supports research and development efforts as directed under Section 219 of the fiscal year 2009 Duncan Hunter National Defense Authorization Act.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Naval Innovative Science and Engineering	1.400	-	-
Description: Funding supports research and development efforts as directed under Section 219 of the fiscal year 2009 Duncan Hunter National Defense Authorization Act. Such efforts are geared to supporting defense Labs in three broad areas. ***FY 2010 Accomplishments:*** - Innovative basic and applied research that is conducted at defense labs and supports military missions. - Developmental programs that support the transition of technologies developed by defense labs into operational use. - Workforce development activities that improve the capacity for defense labs to recruit and retain personnel with needed scientific and engineering expertise.			
Accomplishments/Planned Programs Subtotals	1.400	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

The overall metrics of Section 219 is to increase retention and recruitment; number of advanced degrees, patent awards, and technical papers; successful technology transition to the warfighter; and laboratory ability to conduct innovative research.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602271N: *Electromagnetic Systems Applied Research*	PROJECT 9999: *Congressional Adds*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
9999: *Congressional Adds*	4.780	-	-	-	-	-	-	-	-	0.000	4.780

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011
Congressional Add: Gallium Nitride (GaN) Power Technology ***FY 2010 Accomplishments:*** This effort supported gallium nitride power technology research.	1.593	-
Congressional Add: National Initiatives for Applications of Multifunctional Materials ***FY 2010 Accomplishments:*** This effort studied fundamental properties with the potential to impact widely tunable devices such as filters or phase shifters which are applicable to Navy electronic needs.	1.992	-
Congressional Add: SiC Wafer Production ***FY 2010 Accomplishments:*** This effort supported development of a low-defect silicon carbide (SiC) wafer production process for DoD applications to improve efficiency and tactical abilities of directed energy systems and all-electric vehicle platforms.	1.195	-
Congressional Adds Subtotals	4.780	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Add.