Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification									DATE: May 2009	
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 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	60.187	59.668	64.816						Continuing	Continuing
0000: ELECTROMAGNETIC SYSTEMS APPLIED RESEARCH	60.187	59.668	64.816						Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). 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 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	52.529	54.830	49.764	
Current BES/President's Budget	60.187	59.668	64.816	
Total Adjustments	7.658	4.838	15.052	
Congressional Program Reductions		-0.188		
Congressional Rescissions				
Total Congressional Increases		5.040		
Total Reprogrammings	8.079			
SBIR/STTR Transfer	-0.421			
Program Adjustments			14.970	
Rate/Misc Adjustments		-0.014	0.082	

Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **ENERGY EFFICIENT GALLIUM NITRIDE SEMICONDUCTOR TECHNOLOGY**	0.000	1.037
Project: 9999, **GALLIUM NITRIDE RF POWER TECHNOLOGY**	1.930	1.596
Project: 9999, **MICROWAVE FERRITES AND MULTIFUNCTIONAL INTEGRATED CIRCUITS**	0.771	0.000
Project: 9999, **NATIONAL INITIATIVES FOR APPLICATIONS OF MULTIFUNCTIONAL MATERIALS**	1.543	1.595
Project: 9999, **NOTRE DAME CENTER FOR THE ENGINEERING OF OXIDE NITRIDE STRUCTURES (CEONS)**	1.543	0.000
Project: 9999, **REPARATIVE CORE MEDICINE**	0.965	0.798
Project: 9999, **ULTRA STABLE COHERENT LASER**	0.773	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
0000: ELECTROMAGNETIC SYSTEMS APPLIED RESEARCH	60.187	59.668	64.816						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 Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
ELECTRONIC AND ELECTROMAGNETIC SYSTEMS (FORMERLY ELECTRONICS AND COMMUNICATIONS TECHNOLOGIES)	15.525	14.210	17.670	
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:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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. 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.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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 cognitive 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 surface and airborne 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 and surface-to-surface 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 high frequency (HF) and ultra high frequency (UHF) spectrum will be developed which include beam forming techniques and alternative waveform designs that increase throughput by a factor of four times (4X) by adapting to spectrum and operating conditions. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. The increase from FY 2009 to FY 2010 is associated with initiation of new FNC efforts in the Countermeasure Technologies for Anti-Ship Missile Defense Enabling Capabilities program. *FY 2008 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.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated 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 Millimeter-Wave Integrated Circuits (MMICs) and devices, and began to apply this standard to state-of-the-art (SOA) MMICs and devices. - Completed component chain optimization for Advanced Multifunctional Radio Frequency Concept (AMRFC) Multifunction Electronic Warfare (MFEW) transmitter technology with a target of meeting FY 2011 transition target date. - Initiated the Enhanced Nulka Payload FNC effort by conducting a Transmitter and Receiver Technology Trade Space study. - Initiated the Enhanced Surface Electronic Warfare Improvement Program (SEWIP) Transmitter FNC effort by conducting a Transmitter and Cooling Technology Trade Space study. 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. - Initiated design and development of a X-Band Digital Array Radar (DAR). - Initiated development of Maritime Classification and Identification modes for APY-6. Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: - Completed highly integrated and affordable receiver (RX) component optimization supporting multifunction electronics and array technologies. This includes the optimization of entire component chains of Low Noise Amplifiers (LNAs), Analog-to-Digital Converters (ADCs), tunable filters, channelizers, radiating elements specific to the MFEW receiver, and two-dimensional (2D) electronically scanned arrays for a reduced cost to 1/3 of current multi-function RF systems for a minimum of 6-18 GHz bandwidth. (e)				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiated effort on Affordable Electronically Scanned Array Technology to include electronics component technologies supporting S-band radar, X-band radar and electronic attack. Low Cost over the Horizon Communication, Satellite Communications (SATCOM) and Line of Sight (LOS) Apertures: - Initiated development of technology to provide a set of apertures (Line of Sight, Satellite Communications) and link electronics that are suitable for broad Naval applications. - Initiated development of technology to provide open, programmable core terminal components applicable to multiple platforms to include airborne applications and Marine vehicles. *FY 2009 Plans:* Next Generation Airborne Electronic Attack: - Continue all efforts of FY 2008. Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missile (ASBM) Defense: - Continue all efforts of FY 2008 less those noted as completed above. Long Range Detection and Tracking: - Continue all efforts of FY 2008. Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms: - Continue all efforts of FY 2008 less those noted as completed above. Low Cost over the Horizon Communication, Satellite Communications (SATCOM) and Line of Sight (LOS) Apertures: - Continue all efforts of FY 2008. *FY 2010 Plans:* Next Generation Airborne Electronic Attack:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue all efforts of FY 2009. Countermeasures Technologies for Anti-Ship Cruise Missiles (ASCM) and Anti-Ship Ballistic Missile (ASBM) Defense: - Continue all efforts of FY 2009. Next Generation Countermeasure Technologies for Ship Missile Defense: - Initiate 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: - Continue all efforts of FY 2009. - Complete development 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 2009. Affordable Common Radar Architecture (ACRA): - Initiate development of an Affordable Common Radar Architecture to improve supportability and performance of multiple legacy radars. Low Cost over the Horizon Communication, Satellite Communications (SATCOM) and Line of Sight (LOS) Apertures: - Continue all efforts of FY 2009. SATCOM Vulnerability Mitigation: - Initiate development of advanced techniques for the use of the HF and UHF spectrum, including beam forming and alternative waveforms.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate demonstration of technology components (apertures, cosite mitigation techniques, advanced programmable radios) needed to support Low Cost over the Horizon Communication, SATCOM and LOS links.					
ELECTRONIC WARFARE TECHNOLOGY (FORMERLY RF ELECTRONIC WARFARE TECHNOLOGY) 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. 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: Develop countermeasures and techniques to defeat advanced radio frequency (RF) guided threats to protect high value assets from advanced weapon attack, develop forward deployed jamming systems to		9.239	16.376	16.574	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**

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 Electronic Attack (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.

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

The increase from FY 2008 to FY 2009 is due to initiation of the following efforts: Antennas from VHF to THz, Cueing Receiver for Faster EA Response Management, the Digital Directional Correlator, and research for development of power amplifiers for future RF systems.

FY 2008 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.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed the Countermeasures to Anti-Helicopter Mines (AHM) effort by conducting a field test of the system against AHM or simulators. - Initiated the development of techniques to identify and exploit the processing vulnerability of passive location systems. 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. - Completed the development of an integrated Digital EW, EA and Electronic Support (ES) suite using a tightly coupled common architecture so that there is a synergistic coupling between the sub-functions of ES and EA.) - Completed the Ka/W Band Miniature Sensor Development effort by testing and delivering a prototype sensor system. - Initiated the development of a novel approach to near real time active digital augmentation to improve the isolation of shipboard EW systems. Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: - Continued the investigation of Millimeter Wave (MMW) technologies to support the development of off board and onboard countermeasures. - Continued the design and development of a miniature coherent transponder to counter modern threats using advanced electronic protection techniques. - Continued the development of a series of kinetically driven devices to generate RF. - Completed the Compact Electro-Magnetic (EM) Source for Improvised Explosive Device (IED) and Engine Defeat effort by conducting a field test of an advanced source. - Initiated the development to assess the electronic protection capability of modern missiles using advanced processing and investigated the improvements needed to restore countermeasures effectiveness. Countermeasures and Techniques to Defeat Advanced Electro-Optic/Infrared (EO/IR) Guided Threats:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed the development of analysis/modeling infrastructure and prototype improvement concepts for electronic countermeasures and counter-targeting against RF surveillance threats. - Completed the development and demonstration of a compact EA technology for tactical unmanned vehicle systems to counter wideband, spread spectrum active electronically steered array radars. Modeling and Simulation: - Continued the EW Tactical Decision Algorithm (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. *FY 2009 Plans:* Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2008 less those noted as completed above. - Initiate the Digital Directional Correlator 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. Components and Advanced Architectures/Signal Processing Designs: - Continue all efforts of FY 2008 less those noted as completed above. - Initiate the Miniature 2-70 GHz Integrated Optical Channelizer effort by starting Phase I and specifications development. - Initiate the Cueing Receiver for Faster EA Response Management effort by beginning system design. - Initiate the Antennas from VHF to THz effort through development of the log-periodic antenna. - Initiate 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. Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: - Continue all efforts of FY 2008 less those noted as completed above. - Complete the design and development of a miniature coherent transponder to counter modern threats using advanced electronic protection techniques.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Complete the development of a series of kinetically driven devices to generate RF. - Initiate research for development of power amplifiers for future RF systems. Modeling and Simulation: - Continue all efforts of FY 2008. *FY 2010 Plans:* Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest: - Continue all efforts of FY 2009. - Continue the development of techniques to identify and exploit the processing vulnerability of passive location systems. Transferred from PE 0602271N Supporting Technologies. - Complete the Digital Directional Correlator (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: - Continue all efforts of FY 2009. - Complete the Miniature 2-70 GHz Integrated Optical Channelizer (IOC) effort by fabricating and demonstrating the second generation IOC. - Complete 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. - Complete 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. - Complete the Antennas from VHF to THz effort by testing the final combo antenna from 0.03-110 GHz. - Initiate the Direction Finding of Low Probability of Intercept (LPI) Emitters effort by commencing digital algorithm development. Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats:					

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue all efforts of FY 2009 less those noted as completed above. - Complete 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. - Initiate 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 Electro-Optic/Infrared (EO/IR) Guided Threats: - Initiate 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. - Initiate efforts to Detect and Defeat Imaging IR sensors by developing laser-based countermeasures and advanced IR expendable decoys. Modeling and Simulation: - Continue all efforts of FY 2009. - Complete 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. - Initiate 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. - Initiate the Integrated Onboard/Offboard EA Effectiveness effort by starting investigation with off-board decoy waveforms and structured ship targets. Electronic Protection from Electromagnetic Interference (EMI) and Electronic Attack (EA): - Initiate 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. - Initiate 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.				
EO/IR SENSOR TECHNOLOGIES	0.000	0.000	6.869	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
The overarching objective of this thrust is to develop technologies that enable the development of affordable, wide area, persistent surveillance optical architectures, day/night/all 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. 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 wide field-of-view (WFOV)/narrow field-of-view (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) Unmanned Aerial Vehicle (UAV) Deployable Infrared (IR) Sensor Payloads: Develop unmanned aerial vehicle (UAV) deployable infrared (EO/IR) sensor payloads for persistent surveillance missions.					

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Efforts in this activity were transferred from the Navigation, Electro Optic/Infrared (EO/IR), and Sensor Technologies activity within PE 0602114N. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. In FY 2010, EO/IR efforts previously detailed in the FY 2009 Electronic Warfare Technology Activity are being consolidated into this new activity to provide improved justification of the nature of the funded research and better alignment with future naval needs. Likewise, related research formerly funded and justified in the Navigation, Electro Optic/Infrared (EO/IR) and Sensor Technologies Activity in PE 0602114N is being consolidated into this PE and R2 Activity beginning in FY 2010. Funding levels associated with the consolidated efforts are consistent with prior year totals. *FY 2010 Plans:* Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems: - Continue to perform field demonstration and testing of 94 gigahertz (GHz) passive millimeter wave (MMW) imager. Transferred from PE 0602114N. - Continue 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. - Continue 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. - Complete 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. - Complete the development of an active optics system that can survey a wide area and instantly, non-mechanically zoom-in on an area of interest for target tracking/identification. Transferred from PE 0602114N. - Initiate miniaturization and modularization of MMW imaging system components for small platform systems.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Wide Area Optical Architectures: - Continue 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. - Continue development of mid and long wave IR focal plane arrays using graded-bandgap W-type-II superlattices with much higher detectivity than state-of-the-art Mercury Cadmium Telluride (HgCdTe,MCT) FPAs. Transferred from PE 0602114N. - Complete field and flight testing of foveated zoom imager. Transferred from PE 0602114N - Complete system integration and test of optically agile zoom imager. Transferred from PE 0602114N. - Initiate design of read-out integrated circuits for temporally adaptive focal plane arrays. - Initiate development of spectrally agile visible, near-infrared, short-wave infrared and midwave infrared imaging technology. - Initiate integration of optically and temporally adaptable imaging technologies into sensor for networked persistent surveillance system. High Power Laser Sources: - Complete development of high power fiber lasers in MWIR (2-5 μm) based upon highly nonlinear IR transmitting chalcogenide photonic crystal fibers. Transferred from PE 0602114N.					
NAVIGATION TECHNOLOGY (FORMERLY RF NAVIGATION TECHNOLOGY) 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 Global Positioning System (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:		3.247	2.954	2.807	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
a) GPS Anti-Jam 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 2008 Accomplishments:* GPS Anti-Jam Antennas and Receivers: - Continued the development of GPS AJ Antenna Electronics (AE) with low-cost analog processor 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 Advanced Spoofer Mitigation and Geolocation through Spoofer Tracking project. - Continued the development of GPS Anti-Spoofer Test Facility at NRL. - Continued the installation of GPS simulator at NRL with GAS-1 and other antennas in an anechoic chamber and conduct tests for four GPS AJ systems. - Initiated the GPS Anti-spoofer mitigation by Direction of Arrival (DOA) project. - Initiated the Acquisition Problem in Deeply Integrated GPS Systems project. Precision Time and Time Transfer Technology: - Initiated the Self-Locked Intra-Cavity Alkali Vapor Laser (ICAL) Opto-Atomic Clock project.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated the Precise and Accurate Stamping for Time Transfer Applications (PASTTA) project. Non-GPS Navigation Technology: - Continued the Deeply Integrated Navigation Grade GPS Inertial System project. - Continued the Improved GPS INS Integration using Particle Filter Accelerometer project. - Initiated the Micro Fiber Optical Gyro (MFOG) project. - Initiated the Ship's Passive Inertial Navigation System (SPINS) project. *FY 2009 Plans:* GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2008. - Complete the Advanced Spoofer Mitigation and Geolocation through Spoofer Tracking project. - Complete the development of GPS Anti-Spoofer Test Facility at NRL. - Complete the installation of GPS simulator at NRL with GAS-1 and other antennas in an anechoic chamber and conduct tests for four GPS AJ systems. - Complete the GPS Anti-spoofer mitigation by DOA project. - Complete the Acquisition Problem in Deeply Integrated GPS Systems project. - Initiate the GPS Dual Receiver Hot Start Acquisition (DRHSA) project. - Initiate the GPS Threat Assessment project at NRL. - Initiate the Multi-Frequency Continuously Operating GPS Anomalous Event Monitor (GAEM) project. - Initiate the Precise at-Sea Ship System for Indoor Outdoor Navigation (PASSION). Precision Time and Time Transfer Technology: - Continue all efforts of FY 2008. - Complete the PASTTA project. - Initiate the Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project. Non-GPS Navigation Technology:				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue all efforts of FY 2008. - Complete the Improved GPS/INS Integration using a Particle Filter Accelerator project. - Initiate the Sonar Aided Inertial Navigation Technology (SAINT) project. - Initiate the Optically Transduced Inertial Navigation System (INS) Sensor Suite (OPTIMUSS). *FY 2010 Plans:* GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2009 less those noted as completed above. Precision Time and Time Transfer Technology: - Continue all efforts of FY 2009 less those noted as completed above. Non-GPS Navigation Technology: - Continue all efforts of FY 2009 less those noted as completed above. - Initiate 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. - Initiate development of the SAINT system for littoral application; the SAINT will be applied to the existing Precision Underwater Mapping (PUMA) device.					
SOLID STATE ELECTRONICS The overarching objective of this activity is to develop higher performance components and subsystems for all classes of military radio frequency (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, Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3, 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.		0.000	0.000	8.186	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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), although there are special applications such as JCREW which also require investment in high frequency (HF) through X-band electronics technology. 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, satellite communications (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. 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				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
architectures to deliver ultra-low power, light weight and high performance computational capability for autonomous vehicles and individual warfighters. 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 Plans:* Solid State Transistors and Devices: - Continue development of Antimony (Sb)-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. Transferred from PE 0602271N Supporting Technologies. - Continue development of an integrated tunable frequency selective and low noise integrated module. Transferred from PE 0602271N Supporting Technologies. - Continue effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue MMW field plate GaN HEMT development. Transferred from PE 0602271N Solid State Power Amplifiers. High Efficiency, Highly Linear Amplifiers: - Continue development of MMW AlGaN/GaN wide bandgap HEMT. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue development of AlGaN HEMT broadband amplifiers for electronic warfare decoys with increased power and efficiency than achieved with conventional solid state amplifiers. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue high-efficiency microwave GaN HEMT amplifier development. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue work on GaN MMW components at >44 GHz to allow for EHF SATCOM insertion and other MMW applications spanning to 95GHz. Transferred from PE 0602271N Solid State Power Amplifiers.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue the expansion of scope of the GaN MMW device program. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue component development in support of multifunctional electronic warfare. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue transition of GaN high-efficiency microwave HEMT amplifiers to radar and communications applications. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue development of MMW high efficiency amplifiers for satellite communications and compact high efficiency MMW sources for active denial systems. Transferred from 62271N Solid State Power Amplifiers. - Continue development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications. Transferred from PE 0602271N Solid State Power Amplifiers. - Continue Sub-MMW GaN Device technology for communications, target identification and high speed data processing. Transferred from PE 0602271N Solid State Power Amplifiers. - Complete high efficiency S-Band GaN HEMT amplifier development. Transferred from 62271N Solid State Power Amplifiers. Superconducting Electronics: - Continue development of a second generation superconducting digital channelizer which includes a 1xk multiplier. Transferred from PE 0602271N Supporting Technologies. - Continue 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. Transferred from PE 0602271N Supporting Technologies. - Complete proof of concept demonstration of a wideband, high dynamic range combined LNA and antenna, based on arrays of superonducting quantum interference devices (SQUIDs) on a 1 centimeter squared (cm2) chip for frequencies below 200 megahertz (MHz). Transferred from PE 0602271N Supporting Technologies. Control, Reception, and Processing of Signals: - Continue development of an integrated tunable frequency selective and low noise integrated module.					

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Complete development of Cellular Nonlinear Network (CNN) processing techniques for unmanned air vehicle (UAV)landing applications. Transferred from PE 0602271N Supporting Technologies. - Continue effort to develop a highly linear, low-noise RF amplifier using aligned arrays of single-walled carbon nanotubes. Transferred from PE 0602271N Supporting Technologies. - Continue development of three dimensional (3D)-integrated CNN image sensing processing architecture research. Transferred from PE 0602271N Supporting Technologies.					
SOLID STATE POWER AMPLIFIERS (FORMERLY RF SOLID STATE POWER AMPLIFIERS) This activity provides for the generation of High Frequency (HF), Very High Frequency (VHF), Ultra High Frequency (UHF), Micro Wave (MW), and Millimeter Wave (MMW) power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, JCREW 3, and smart weapons 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, linearity, bandwidth, weight, and size. The current specific objective is: Develop high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications. The funds increase from FY 2008 to FY 2009 is due to a realignment of funds in FY 2008 from this activity to support higher priority requirements in the Surveillance Technology activity. All FY 2010 efforts in this activity have been transferred to the newly created Solid State Electronics activity to provide for better alignment between future naval needs and the solid state research being conducted. *FY 2008 Accomplishments:* High Efficiency, Highly Linear Amplifiers for Microwave, Millimeter-Wave, Low-Noise, and Power Applications:		3.573	4.322	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued development of MMW Aluminum Gallium Nitride/Gallium Nitride (AlGaN/GaN) wide bandgap High Electron Mobility Transistor (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 Field-Plate GaN HEMT Device development for MMW amplifiers. - Continued high-efficiency microwave GaN HEMT amplifier development. - Continued effort to develop W-band high-power GaN Metal-Insulator-Semiconductor (MIS) transistors. - Continued work on GaN MMW components at greater than (>)44 GHz to allow for Extremely High Frequency (EHF) satellite communications (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. - Initiated transition of GaN high-efficiency microwave HEMT amplifiers to radar and communications applications. - Initiated development of MMW High efficiency amplifiers for satellite communications and compact high efficiency MMW sources for active denial systems. - Initiated development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications. - Initiated Sub-MMW GaN Device technology for communications, target identification and high speed data processing. *FY 2009 Plans:* High Efficiency, Highly Linear Amplifiers for Microwave, Millimeter-Wave, Low-Noise, and Power Applications: - Continue all efforts of FY 2008. - Complete high efficiency microwave GaN HEMT amplifier development. Note: In addition to being performed here in FY 2009 the following efforts also transfer to the newly-created Solid State Electronics activity in FY 2010. - Continue development of MMW AlGaN/GaN wide bandgap HEMT.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue development of AlGaN HEMT broadband amplifiers for electronic warfare decoys with increased power and efficiency than achieved with conventional solid state amplifiers. - Continue MMW field plate GaN HEMT development. - Continue work on GaN MMW components at >44 GHz to allow for EHF SATCOM insertion and other MMW applications spanning to 95GHz. - Continue the expansion of scope of the GaN MMW device program. - Continue component development in support of multifunctional electronic warfare. - Continue transition of GaN high-efficiency microwave HEMT amplifiers to radar and communications applications. - Continue development of MMW high efficiency amplifiers for satellite communications and compact high efficiency MMW sources for active denial systems. - Continue development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications. - Continue Sub-MMW GaN Device technology for communications, target identification and high speed data processing. - Initiate Sub-MMW GaN amplifier development.					
SUPPORTING TECHNOLOGIES		5.444	5.232	0.000	
Supporting Technologies provide for the radiation, reception, signal control and processing of Very High Frequency (VHF), Ultra High Frequency (UHF), Micro Wave (MW), and Millimeter Wave (MMW) power for Navy all-weather radar, surveillance, reconnaissance, Electronic Attack (EA), communications, smart weapons, networked sensors, and precision time and navigation systems. Supporting Technologies is characterized by research outside of radio frequency (RF) amplifiers, with emphasis in superconducting electronics and nanoelectronics technology. The technology developed which includes nanotechnology cannot, for the most part, be obtained through commercial off the shelf systems (COTS) as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. The current specific objectives are: a) Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest Anywhere in the Electromagnetic Spectrum: Develop sensors for the purpose of detection, localization,					

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**

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) Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: Develop countermeasures and techniques to defeat advanced radio frequency (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.

c) Solid State Transistors and Devices for High Frequency Analog and Digital Operation: Develop solid state transistors and devices for high frequency analog and digital operation.

d) 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, satellite communications (SATCOM), EW, signal intelligence (SIGINT), and communications.

e) Control, Reception, and Processing of Signals: Develop electronics technology that provides for the control, reception, and processing of signals.

f) 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.

g) New Concepts for Ultrasensitive, Nano-Based Sensors: Develop new concepts for ultrasensitive, nano-based sensors.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
All FY 2010 efforts in this activity have been transferred to the newly-created Solid State Electronics activity to provide for better alignment with future naval needs. *FY 2008 Accomplishments:* Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest Anywhere in the Electromagnetic Spectrum: - Initiated the development of techniques to identify and exploit the processing vulnerability of passive location systems. Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: - Initiated the development to assess the electronic protection capability of modern missiles using advanced processing and investigated the improvements needed to restore countermeasures effectiveness. - Completed the development of analysis/modeling infrastructure and prototype improvement concepts for electronic countermeasures and counter-targeting against RF surveillance threats. Solid State Transistors and Devices for High frequency Analog and Digital Operation: - Continued development of 6.2-6.3 Angstrom Heterojunction Bipolar Transistor (HBT) operating at microwave frequencies. - Initiated development of Antimony (Sb)-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. Superconducting Electronics: - Continued development of a second generation superconducting digital channelizer which includes a 1xk multiplier.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued demonstration of an improved signal processing technique that can be applied to state-of-the-art L, S, X, and Ka-band superconducting bandpass analog-to-digital converters (ADCs) to realize an improvement in dynamic range of greater than 6 decibels (dB). - Completed demonstration of a current recycling technology for superconducting digital circuits that is mature enough to yield a four fold reduction of bias current. - Continued proof of concept lab demonstration of a wideband, high dynamic range combined LNA and antenna, based on arrays of superonducting quantum interference devices (SQUIDs) on a 1 centimeter squared (cm2) chip for frequencies below 200 megahertz (MHz). Control, Reception, and Processing of Signals: - Initiated development of an integrated tunable frequency selective and low noise integrated module. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures: - Initiated 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. - Initiated development of three dimensional (3D)-integrated CNN image sensing processing architecture research. New Concepts for Ultrasensitive, Nano-Based Sensors: - Completed effort to develop carbon nanotube sensors for trace-level vapor detection of explosives, chemical agents, and toxic industrial chemicals. *FY 2009 Plans:* Note: In addition to being performed here in FY 2009, the following efforts also transfer to the Electronic Warfare Activity in FY 2010. Sensors for the Purpose of Detection, Localization, and Identification of Hostile Signals of Interest Anywhere in the Electromagnetic Spectrum:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue development of techniques to identify and exploit the processing vulnerability of passive location systems. Countermeasures and Techniques to Defeat Advanced Radio Frequency (RF) Guided Threats: - Continue development to assess the electronic protection capability of modern missiles using advanced processing and investigated the improvements needed to restore countermeasures effectiveness. Note: In addition to being performed here in FY 2009, the following efforts also transfer to the newly created Solid State Electronics Activity in FY 2010. Solid State Transistors and Devices for High Frequency Analog and Digital Operation: - Continue development of Antimony (Sb)-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. - Initiate effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. Superconducting Electronics: - Continue 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. - Continue proof of concept lab demonstration of a wideband, high dynamic range combined LNA and antenna, based on arrays of superonducting quantum interference devices (SQUIDs) on a 1 centimeter squared (cm2) chip for frequencies below 200 megahertz (MHz). - Continue development of a second generation superconducting digital channelizer which includes a 1xk multiplier. Control, Reception, and Processing of Signals: - Continue development of an integrated tunable frequency selective and low noise integrated module. Novel Nanometer Scale Logic/Memory Devices and Related Circuits and Architectures:				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue development of Cellular Nonlinear Network (CNN) processing techniques for unmanned air vehicle (UAV) landing applications. - Continue effort to develop a highly linear, low-noise RF amplifier using aligned arrays of single-walled carbon nanotubes. - Continue development of three dimensional (3D)-integrated CNN image sensing processing architecture research.					
SURVEILLANCE TECHNOLOGY (FORMERLY RF SURVEILLANCE TECHNOLOGY) 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 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.		12.728	8.640	9.120	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
d) Small UAV Collision Avoidance/Autonomy Technology: Develop small UAV collision avoidance/ autonomy technology. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. The decrease from FY 2008 to FY 2009 is due to the initiation via reprogramming and completion during FY 2008 of preliminary Applied Research required to support the Integrated Topside (INTOP) Innovative Naval Prototype effort. The INTOP multi-year Advanced Technology Development effort initiates in FY 2009 in PE 0603271N. *FY 2008 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. - Completed the design and development of a field probe and radome assembly for a real-time calibration technique that will utilize an optical-to-radio frequency (RF) distribution network to inject a low-level RF continuous wave (CW) signal into each element of a phased array. Demonstrated the polarization properties of a wideband probe using a zero-bias optical detector. 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.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continued a program to develop and demonstrate methodologies that provide small threat radar detection in the presence of large masking radar returns using an Adaptive Pulse Compression technique. - Continued the assessment of vulnerabilities of modern side lobe canceling (SLC) algorithms to adversary jamming and develop mitigating SLC design improvements. - Initiated the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenged environments. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Initiated the development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment. *FY 2009 Plans:* Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2008 less those noted as completed above. - Initiate the requirements analysis and trade studies of an Advanced Common Radar Architecture. Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration and Feature Extraction: - Continue all efforts of FY 2008. - Complete a program to develop and demonstrate methodologies that provide small threat radar detection in the presence of large masking radar returns using an Adaptive Pulse Compression technique. - Initiate investigation of means of optimally combining mensuration, classification, and non-cooperative target recognition of surface craft. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Continue all efforts of FY 2008.					

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Small UAV Collision Avoidance/Autonomy Technology: - Initiate development of research technologies and analytical algorithms for an effective and highly reliable collision avoidance system. *FY 2010 Plans:* Radar Architectures, Sensors, And Software which Address Ballistic Missile and Littoral Requirement Shortfalls: - Continue all efforts of FY 2009. - Initiate 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: - Continue all efforts of FY 2009 less those noted as completed above. - Complete the assessment of vulnerabilities of modern side lobe canceling (SLC) algorithms to adversary jamming and develop mitigating SLC design improvements. - Initiate development of a technology architecture for the Persistent Autonomous Surveillance System. - Initiate development of automated controls for an airborne persistent multi-node sensor network. Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: - Complete 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: - Continue all efforts of FY 2009.					
VACUUM ELECTRONICS POWER AMPLIFIERS (FORMERLY RF VACUUM ELECTRONICS POWER AMPLIFIERS) 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		2.906	2.908	3.590	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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. Funds increase in FY 2010 associated with increased activity and investment in Vacuum Electronics research at the Naval Research Laboratory specific to coupled-cavity 2D algorithms. *FY 2008 Accomplishments:* High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continued research effort on generation and transport of sheet beam with 5:1 aspect ratio.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed research on three dimensional (3D) modeling of beam transport with quadrapole magnetic focusing for high power Ka band Traveling Wave Tube (TWT). - Completed effort on experimental demonstration of beam propagation with quadrapole magnetic focusing that will result in a factor of 3 reduction in magnet volume and weight compared to Permanent Periodic Magnet (PPM) focusing system. 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 developing and implementing models for multi-gap cavity coupling in TESLA for klystrons. - Completed the effort on the development and implementation of models and algorithms for electron emission physics in gun/collector code MICHELLE. - Completed the effort on developing algorithms and models in 1D CHRISTINE_CC for coupled cavity (CC) TWT's. - Initiated the effort on the development and implementation of models and algorithms in the large signal CHRISTINE 3D code to create capabilities for an end-to-end analysis of a Helix TWT. - Initiated the effort on the development and implementation of models and algorithms in a large signal klystron code to model sheet electron beam – wave interaction. - Initiated the effort on developing models and algorithms based on generalized model expansion (GENOME) techniques for large signal modeling of extended interaction klystrons (EIK). *FY 2009 Plans:* High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2008 less those noted as completed above. - Complete research effort on generation and transport of sheet beam with 5:1 aspect ratio. - Initiate the development of high-current-density cathodes based on diamond current amplifier.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate 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. - Initiate the development of new spatially-distributed electron beam traveling-wave amplifier structures incorporating novel mode suppression techniques. Lithographic Fabrication Techniques: - Initiate effort to develop 220 GHz millimeter-wave amplifiers employing electromagnetic structures that are microfabricated using lithographic techniques. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Continue all efforts of FY 2008 less those noted as completed above. - Complete the effort on developing and implementing models for multi-gap cavity coupling in TESLA for klystron. - Initiate the effort on the development and implementation of models and algorithms in a large signal TWT code to model sheet electron beam – wave interaction. - Initiate the effort on the development of nonlinear stability analysis for broadband CC-TWT. *FY 2010 Plans:* High Power Millimeter and Upper Millimeter Wave Amplifiers: - Continue all efforts of FY 2009 less those noted as completed above. Lithographic Fabrication Techniques: - Continue all efforts of FY 2009. Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: - Continue all efforts of FY 2009 less those noted as completed above. - Complete nonlinear stability analysis for the broadband CC-TWT. - Complete an end-to-end analysis of a Helix TWT using the large signal CHRISTINE 3D code. - Initiate development of coupled-cavity 2D algorithms in TESLA for the CC-TWT.					

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
PE 0601102A/Defense Research Sciences									Continuing	Continuing
PE 0601102F/Defense Research Sciences									Continuing	Continuing
PE 0601153N/Defense Research Sciences									Continuing	Continuing
PE 0602114N/Power Projection Applied Research									Continuing	Continuing
PE 0602123N/Force Protection Applied Research									Continuing	Continuing
PE 0602204F/Aerospace Sensors									Continuing	Continuing
PE 0602702F/ Command Control and Communications									Continuing	Continuing
PE 0602716E/Electronics Technology									Continuing	Continuing
PE 0603114N/Power Projection Advanced Technology									Continuing	Continuing
PE 0603123N/Force Protection Advanced Technology									Continuing	Continuing
PE 0603271N/ Electromagnetic Systems Advanced Technology									Continuing	Continuing

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D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Performance Metrics are discussed within the R-2a.

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