Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Navy										DATE: February 2010	
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 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base Estimate**	**FY 2011 OCO Estimate**	**FY 2011 Total Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	61.439	69.327	83.902	0.000	83.902	80.672	86.146	85.615	89.534	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	56.413	64.547	83.902	0.000	83.902	80.672	86.146	85.615	89.534	Continuing	Continuing
9999: *Congressional Adds*	5.026	4.780	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	42.582

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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Navy	DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	**R-1 ITEM NOMENCLATURE** PE 0602271N: *Electromagnetic Systems Applied Research*

B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	59.668	64.816	0.000	0.000	0.000
Current President's Budget	61.439	69.327	83.902	0.000	83.902
Total Adjustments	1.771	4.511	83.902	0.000	83.902
• Congressional General Reductions		-0.289			
• Congressional Directed Reductions		0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds		4.800			
• Congressional Directed Transfers		0.000			
• Reprogrammings	2.867	0.000			
• SBIR/STTR Transfer	-1.096	0.000			
• Program Adjustments	0.000	0.000	83.902	0.000	83.902

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2009	FY 2010
Project: 9999: *Congressional Adds*		
Congressional Add: *Silicon Carbide Wafer Production- Process Development For Low Defect Power Electronics*	0.000	1.195
Congressional Add: *Energy Efficient Gallium Nitride Semiconductor Technology*	1.037	0.000
Congressional Add: *Gallium Nitride RF Power Technology*	1.596	1.593
Congressional Add: *National Initiatives for Applications of Multifunctional Materials*	1.595	1.992
Congressional Add: *Reparative Core Medicine*	0.798	0.000
Congressional Add Subtotals for Project: 9999	5.026	4.780
Congressional Add Totals for all Projects	5.026	4.780

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Navy	DATE: February 2010
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FY11 from previous President's Budget is shown as zero because no FY11-15 data was presented in President's Budget 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy			DATE: February 2010
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*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
0000: *Electromagnetic Systems Applied Research*	56.413	64.547	83.902	0.000	83.902	80.672	86.146	85.615	89.534	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 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
ELECTRONIC AND ELECTROMAGNETIC SYSTEMS	13.611	17.666	30.700	0.000	30.700
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					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. 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) 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					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. 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. 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 Global Applications for Data EXfiltration (GLADEX). - 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. *FY 2009 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:					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. 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. 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. Low Cost over the Horizon Communication, Satellite 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. *FY 2010 Plans:* Next Generation Airborne Electronic Attack: - Continue all efforts of FY 2009.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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, SATCOM and LOS Apertures: - Continue all efforts of FY 2009. SATCOM Vulnerability Mitigation: - Initiate wideband infrastructure architecture design and development, development of alternative waveforms and development of advanced techniques for use of the spectrum.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Initiate 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 Base 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 less those noted as completed above. - 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 2010.					
Affordable Common Radar Architecture (ACRA):					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Continue all efforts of FY 2010. Low Cost over the Horizon Communication, SATCOM and LOS Apertures: - Continue all efforts of FY 2010. - Complete development of low cost satellite, airborne and shipboard apertures; demonstrate components in laboratory and realistic field environments. 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. Global Applications for Data Exfiltration (GLADEX): - 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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
ELECTRONIC WARFARE TECHNOLOGY	16.107	17.797	23.311	0.000	23.311

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 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.

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. 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. *FY 2009 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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Initiated 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: - 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. - Initiated the Miniature 2-70 GHz Integrated Optical Channelizer effort by starting Phase I and specifications development. - Initiated the Cueing Receiver for Faster EA Response Management effort by beginning system design. - Initiated the Antennas from VHF to THz effort through development of the log-periodic antenna. - Initiated 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 RF Guided Threats: - Continued the investigation of Millimeter Wave (MMW) technologies to support the development of off board and onboard countermeasures. - Continued the assessment of the electronic protection capability of modern missiles using advanced processing and investigated the improvements needed to restore countermeasures effectiveness. - Completed the design and development of a miniature coherent transponder to counter modern threats using advanced electronic protection techniques. - Completed the development of a series of kinetically driven devices to generate RF. - Initiated research for development of power amplifiers for future RF systems.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. Acquisition Workforce Fund: - Funded DoD Acquisition Workforce Fund. *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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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 RF Guided Threats: - 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 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Initiate the Integrated Onboard/Offboard EA Effectiveness effort by starting investigation with offboard decoy waveforms and structured ship targets. Electronic Protection from EMI and 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. *FY 2011 Base 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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: - Continue all efforts of FY 2010 less those noted as completed above. - Complete the Real-Time EA Effectiveness Monitoring effort by finalizing prototype integration and conducting concept demonstration field testing. - Complete the Integrated Onboard/Offboard EA Effectiveness effort by developing robust Measures of Effectiveness (MOE) for onboard/offboard field trials. Electronic Protection from EMI and EA: - Continue all efforts of FY 2010.					
EO/IR SENSOR TECHNOLOGIES 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:	0.000	7.022	7.324	0.000	7.324

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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 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. 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					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
research and better alignment with future naval needs. Likewise, related research formerly funded and justified in the Navigation, 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, nonmechanically 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. 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 Wtype-II superlattices with much higher detectivity than state-of-the-art Mercury Cadmium Telluride					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
(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 1/4m) based upon highly nonlinear IR transmitting chalcogenide photonic crystal fibers. Transferred from PE 0602114N. *FY 2011 Base Plans:* Optically Based Terahertz (THz)and Millimeter Wave Distributed Aperture Systems: - Continue all efforts of FY 2010 less those noted as completed above. - 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:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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.					
NAVIGATION TECHNOLOGY	3.468	2.738	2.835	0.000	2.835
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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2009 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. - Completed the Advanced Spoofer Mitigation and Geolocation through Spoofer Tracking project. - Completed the development of GPS Anti-Spoofer Test Facility. - Completed the installation of GPS simulator with GAS-1 and other antennas in an anechoic chamber and conduct tests for four GPS AJ systems. - Completed the GPS Anti-spoofer mitigation by DOA project. - Completed the Acquisition Problem in Deeply Integrated GPS Systems project. - Initiated the GPS Dual Receiver Hot Start Acquisition (DRHSA) project. - Initiated the GPS Threat Assessment project. - Initiated the Multi-Frequency Continuously Operating GPS Anomalous Event Monitor (GAEM) project. - Initiated 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. - Completed the Precise and Accurate Stamping for Time Transfer Applications project. - Initiated the Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. - Completed the Improved GPS/INS Integration using a Particle Filter Accelerator project. - Initiated the Sonar Aided Inertial Navigation Technology (SAINT) project. - Initiated the Optically Transduced Inertial Navigation System (INS) Sensor Suite (OPTIMUSS) project. *FY 2010 Plans:* GPS AJ 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. *FY 2011 Base Plans:* GPS Anti-Jam Antennas and Receivers: - Continue all efforts of FY 2010. - Complete GPS AJ Antenna Electronics effort.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. 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.					
SOLID STATE ELECTRONICS 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,	0.000	7.975	8.149	0.000	8.149

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
specific function systems. These improved components are based on both silicon (Si) and compound semiconductors (especially the wide bandgap materials and narrow bandgap materials), low and high temperature superconductors, novel nanometer scale structures and materials. Components addressed by this activity emphasize the MMW and submillimeter wave (SMMW) regions with an increasing emphasis on devices capable of operating in the range from 50 gigahertz (GHz) to 10 terahertz (THz). The functionality of the technology developed cannot be obtained through Commercial-Off-the-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, operational and instantaneous bandwidth, weight, and size. Effort will involve understanding the properties of engineered semiconductors as they apply to quantum information science and technology. 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 Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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 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 High Electron Mobility Transistor (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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. - 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 PE 0602271N 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 PE 0602271N 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-ofthe-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 superconducting quantum interference devices (SQUIDs) on a 1					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. - Continue 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: - 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. *FY 2011 Base 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:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Complete development of a second generation superconducting digital channelizer which includes a 1xk multiplier. - 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 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. 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. - Initiate new effort in assessment of scalable nanoarchitectures. - Initiate new effort in sub-10nm nanofabrication.					
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 allweather radar, surveillance, reconnaissance, electronic attack, communications, 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.	4.182	0.000	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
The current specific objective is: Develop high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications. 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 2009 Accomplishments:* High Efficiency, Highly Linear Amplifiers for Microwave, Millimeter-Wave, Low-Noise, and Power Applications: - Completed high efficiency microwave Gallium Nitride High Electron Mobility Transistor amplifier development. Note: In addition to being performed here in FY 2009 the following efforts also transfer to the newlycreated Solid State Electronics activity in FY 2010. - Continued development of MMW Aluminum Gallium Nitride (AlGaN)/Gallium Nitride 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 MMW field plate GaN HEMT development. - Continued effort to develop W-band high-power GaN Metal-Insulator-Semiconductor (MIS) transistors. - Continued work on GaN MMW components at >44 GHz to allow for Extremely High Frequency (EHF) SATCOM insertion and other MMW applications spanning to 95GHz. - Continued the expansion of scope of the GaN MMW device program.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. - Initiated Sub-MMW GaN amplifier development.					
SUPPORTING TECHNOLOGIES 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 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, 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.	6.580	0.000	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
b) Countermeasures and Techniques to Defeat Advanced RF Guided Threats: Develop countermeasures and techniques to defeat advanced RF guided threats to protect high value assets from advanced weapon attack, develop forward deployed jamming systems to negate advanced RF surveillance systems, and deny enemy usage of 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, 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. All FY 2010 efforts in this activity have been transferred to the newly-created Solid State Electronics					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
activity to provide for better alignment with future naval needs. *FY 2009 Accomplishments:* 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: - Continued development of techniques to identify and exploit the processing vulnerability of passive location systems. Countermeasures and Techniques to Defeat Advanced RF Guided Threats: - Continued 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: - Continued development of Antimony (Sb)-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. - Initiated effort to develop W-band high-power Gallium Nitride (GaN) Metal Insulator Semiconductor (MIS) transistors. Superconducting Electronics: - Continued demonstration of an improved signal processing technique that can be applied to state-of-the-					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
art L, S, X, and Ka-band superconducting bandpass ADCs to realize an improvement in dynamic range of greater than 6dB. - Continued proof of concept lab 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). - Continued development of a second generation superconducting digital channelizer which includes a 1xk multiplier. Control, Reception, and Processing of Signals: - Continued development of an integrated tunable frequency selective and low noise integrated module. - Initiated 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: - Continued development of Cellular Nonlinear Network (CNN) processing techniques for UAV landing applications. - Continued effort to develop a highly linear, low-noise RF amplifier using aligned arrays of singlewalled carbon nanotubes. - Continued development of three dimensional (3D)-integrated CNN image sensing processing architecture research.					
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	8.949	7.965	8.170	0.000	8.170

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. 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. *FY 2009 Accomplishments:* Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. - Initiated 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: - 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. - Continued the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenged environments. - Completed 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. - Initiated investigation of means of optimally combining mensuration, classification, and noncooperative target recognition of surface craft. 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:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Initiated 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. *FY 2011 Base Plans:* Radar Architectures, Sensors, and Software which Address Ballistic Missile and Littoral Requirement Shortfalls:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. Small UAV Collision Avoidance/Autonomy Technology: - Continue all efforts of FY 2010.					
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 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	3.516	3.384	3.413	0.000	3.413

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
structures. b) Lithographic Fabrication Techniques: Develop lithographic fabrication techniques for upper-millimeter wave amplifiers. c) Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: Develop accurate and computationally effective device-specific multi-dimensional models for electron beam generation, large-signal and stability analysis to simulate device performance and improve the device characteristics. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2009 Accomplishments:* High Power Millimeter and Upper Millimeter Wave Amplifiers: - Completed research effort on generation and transport of sheet beam with 5:1 aspect ratio. - Initiated the development of high-current-density cathodes based on diamond current amplifier. - Initiated 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. - Initiated the development of new spatially-distributed electron beam traveling-wave amplifier structures incorporating novel mode suppression techniques. Lithographic Fabrication Techniques: - Initiated 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:					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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 the large signal CHRISTINE 3D code to create capabilities for an end-to-end analysis of a Helix traveling wave tube (TWT). - 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). - Completed the effort on developing and implementing models for multi-gap cavity coupling in TESLA for klystrons. - Initiated the effort on the development and implementation of models and algorithms in a large signal TWT code to model sheet electron beam - wave interaction. - Initiated the effort on the development of nonlinear stability analysis for broadband coupled cavity - traveling wave tube (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.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 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. *FY 2011 Base 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. - Initiate development of parallel version of MICHELLE for gun/collector code to reduce computational time by factor of 10 for realistic 3D electron beams.					
Accomplishments/Planned Programs Subtotals	56.413	64.547	83.902	0.000	83.902

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	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.

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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.

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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
9999: *Congressional Adds*	5.026	4.780	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	42.582

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
Congressional Add: Silicon Carbide Wafer Production- Process Development For Low Defect Power Electronics *FY 2010 Plans:* This effort supports Silicon Carbide Wafer Production-Process Development for LOW Defect Power Electronics research.	0.000	1.195
Congressional Add: Energy Efficient Gallium Nitride Semiconductor Technology *FY 2009 Accomplishments:* This effort supported the initiation of device design and development of fabrication processes for normally-off Gallium Nitride-based switches was investigated. The development of this technology will advance compact, efficient power conversion on mobile platforms.	1.037	0.000
Congressional Add: Gallium Nitride RF Power Technology	1.596	1.593

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: This effort supported the process development of Gallium Nitride HEMTs and initiated studies for related processes for MMIC development. This effort contributes to the development of high volume manufacturing of reliable GaN-based RF components for Navy communications systems. *FY 2010 Plans:* Continues support of Gallium Nitride (GAN) Power Technology research.		
Congressional Add: National Initiatives for Applications of Multifunctional Materials *FY 2009 Accomplishments:* This effort supported the development of these materials to enable new concepts in passive RF components for filter applications. Equipment was procured for the support of the multifunctional materials project. *FY 2010 Plans:* Continues support of National Initiatives for Applications of Multifunction Materials research.	1.595	1.992
Congressional Add: Reparative Core Medicine *FY 2009 Accomplishments:* This effort supported the development of methods to permit the production of safe functioning blood cells for transfusion. The objective is to eliminate the need for human donors of blood.	0.798	0.000
Congressional Adds Subtotals	5.026	4.780

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C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Congressional Add.