

UNCLASSIFIED

FY 2008/2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET
Exhibit R-2

DATE: February 2007

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N
PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	98,749	98,065	22,676	29,566	53,246	63,072	77,175	82,865
2913 RF SYSTEMS ADVANCED TECHNOLOGY	72,818	45,146	22,676	29,566	53,246	63,072	77,175	82,865
9999 CONGRESSIONAL PLUS-UPS	25,931	52,919	0	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Activities and efforts in this Program Element (PE) address technologies critical to enabling the transformation of discrete functions to network centric warfare capabilities which simultaneously perform Radar, Electronic Warfare (EW), and Communications and Network functions across platforms through multiple, simultaneous and continuous communications/data links. The Radio Frequency (RF) Systems Advanced Technology program addresses RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The Program emphasizes near to mid-term transition opportunities by developing and demonstrating technologies supporting the Future Naval Capabilities (FNC) Program Enabling Capabilities (ECs) for Multi-Source Intelligence, Surveillance, and Reconnaissance (ISR) for the Warfighter, Long Range Detection and Tracking, Advanced Electronic Sensor Systems for Missile Defense, Marine and all types/forms of Unmanned Vehicles (UxV) Tactical ISR, Next Generation Airborne Electronic Attack, Advanced Communication for FORCEnet, GIG-Compliant Networking, Low Cost Over the Horizon Communication, Satellite Communication (SATCOM) and Line of Sight (LOS) Apertures, and Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Within the Naval Transformational Roadmap, this investment offers affordable options for the transformational capabilities required by the Sea Shield (Theater Air and Missile Defense), Sea Strike (Persistent Intelligence, Surveillance, and Reconnaissance), and ForceNet (Communications and Networking) SeaPower 21 Naval Warfighting Pillars.

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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:

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
FY 2007 President's Budget Submission	100,982	45,317	2,627	26,782
Congressional Action	0	53,120	0	0
Congressional Undistributed Reductions/Rescissions	-330	-372	0	0
Execution Adjustments	376	0	0	0
Federal Technology Transfer	-21	0	0	0
Non-Pay Inflation Adjustments	0	0	-135	93
Program Adjustments	0	0	5,146	1,945
Program Realignment	0	0	14,982	652
Rate Adjustments	0	0	56	94
SBIR Assessment	-2,258	0	0	0
FY 2008/FY 2009 President's Budget Submission	98,749	98,065	22,676	29,566

PROGRAM CHANGE SUMMARY EXPLANATION:

Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:

Not applicable.

D. ACQUISITION STRATEGY:

Not applicable.

E. PERFORMANCE METRICS:

Advanced Electronic Sensor Systems for Missile Defense and Long Range Detection and Tracking ECs are aligned to the Navy's Advanced Cruiser (CG(X)) plans and closely coordinated with Naval Sea Systems Command Integrated Warfare Systems (PEO IWS 2.0). Multi-Source ISR to the Warfighter supports the Navy's Advanced Destroyer

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(DD(X)) Electronic Surveillance requirements and is closely coordinated with PEO IWS 2.0. Marine and UxV Tactical ISR supports Program Manager Aviation (PMA) 263 Broad Area Maritime Surveillance (BAMS) acquisition strategy. Advanced Communications for ForceNet is aligned with a number of acquisition programs ranging from undersea warfare to carriers. Other performance metrics are discussed within the R-2a.

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PROJECT NUMBER: 2913 PROJECT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2913 RF SYSTEMS ADVANCED TECHNOLOGY	72,818	45,146	22,676	29,566	53,246	63,072	77,175	82,865

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The RF Systems Advanced Technology Thrust addresses technologies critical to enabling the affordable transformation of discrete functions to network centric warfare, utilizing multiple, simultaneous, and continuous communications/data links between platforms while simultaneously performing the functions of Radar and EW. Work in this thrust addresses cost-effective RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The thrust emphasizes near to mid-term transition opportunities by developing and demonstrating technologies which enable affordable options for transformational capabilities required by the Sea Shield, Sea Strike, and ForceNet pillars.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2006	FY 2007	FY 2008	FY 2009
ADVANCED MULTI-FUNCTION RF TECHNOLOGY	43,136	45,146	22,676	29,566

This effort develops, demonstrates, and transitions affordable wideband, high performance Advanced Multifunction Radio Frequency (AMRF) apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams while providing reduced signature and numbers of apertures. Program activity goals include development and demonstration of multi functional RF technologies applicable to systems development for Advanced Destroyers (DD(X)), Advanced Cruisers (CG(X)), Aircraft Carriers (CVNs), and other ship classes. These technologies will provide reduced recurring costs for total system functionality; reduced number of topside antennas and support systems; reduced ship radar cross section; reduced number of unique spares and lower ship manning requirements; ability to upgrade systems and capabilities with reduced cost, time, and complexity while mitigating the risk of obsolescence; and ability to rapidly exploit technological innovation through open systems concepts. This activity also includes Multifunction Systems Technology developments that

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directly support the Department of Defense Joint Warfighter Science and Technology Plan and the Defense Technology Area Plans.

Major objectives include:

Affordable, open architecture Digital Array Radar for CG(X). Development, testing, and technology demonstration of communications, electronic attack, electronic surveillance, and radar functions in multi-function apertures. Development of a Multi Function Electronic Warfare/Electronic Surveillance (MFEW/ES) Advanced Development Model (ADM) architecture demonstrating key ES capabilities for several simultaneous ES functions and capable of supporting additional RF functions. Conducting MFEW/ES ADM testing that satisfies DD(X) acquisition program Technology Development (TD) phase requirements to enable a smooth transition of AMRF technology to the DD(X) System Development and Demonstration (SDD) Acquisition Phase with minimal changes in system architecture. Electronic Attack (EA) Techniques maintain effective countermeasures in the face of increasingly sophisticated naval threats.

Budget decrease from FY 2007 to FY 2008 is due to completion of the following efforts:

- MFEW/ES FNC effort.
- Digital Array Radar Prototype Components FNC effort.
- EA Techniques to Counter Advanced Threats FNC effort.

Budget increase from FY 2008 to FY 2009 is due to initiation of the Integrated Digital Apertures and Array Radar System (IDAARS).

FY 2006 Accomplishments:

- Continued the MFEW/ES Program Technology Development Phase.
- Continued operation of the wideband multi-function Communications and EW testbed in support of multi-function system development and multi-function technology insertion and demonstration for the AMRF-C effort.
- Continued MFEW/ES Core Software Development.
- Continued Shipboard EO/IR Closed Loop Self-Protection effort.
- Continued development of a High Band array antenna capable of simultaneously supporting multiple Electronic Support Measures (ESM) surveillance functions for the MFEW/ES ADM, providing 4 high gain high sensitivity Electronics Support Measures beams.

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- Continued development of a Mid Band array antenna capable of simultaneously supporting multiple ESM functions for the MFEW/ES ADM.
- Continued development of back-end analog receiver equipment supporting MFEW/ES ADM.
- Continued systems integration, risk reduction, and Navy critical subsystem development effort leading to demonstration of MFEW/ES ADM in a relevant environment and support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Continued development of S-band Digital Array Radar, enabling simultaneous Sea Based Terminal (SBT) and Anti-Air Warfare (AAW) missions.
- Continued the Advanced Technology Development phase of the EA Techniques to Counter Advanced Threats effort by commencing laboratory demonstration of synthetic sea clutter EA waveforms with a timing resolution of 20 nanoseconds.
- Completed the integration and testing of the Real Time Precision Search & Track (PS&T) Radar, providing 360 degree maritime surveillance.
- Completed code development to test the Frequency Modulation (FM) module using the Validation Test Set for the Electronic Attack (EA) Techniques to Counter Advanced Threats effort.

FY 2007 Plans:

- Continue all efforts of FY 2006 less those noted as completed above.
- Complete the MFEW/ES Program Technology Development Phase, demonstrating complete systems integration, risk reduction, and Navy critical subsystem development leading to demonstration of MFEW/ES ADM in a relevant environment, and continued to support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Complete development of S-band Digital Array Radar prototype components development.
- Complete the EA Techniques to Counter Advanced Threats effort by conducting field testing of the Coherent EA Advanced Techniques Generator (ATG) and Digital Radio Frequency Memory (DRFM) Hardware containing a field programmable gate array (FPGA) development board that is capable of operating at 200 MHz.
- Initiate Shipboard EW Improvement and EA Transmitter projects to develop Electronic Warfare/Electronic Attack capability for rapid technology insertion into DD(X) and other ship classes utilizing MFEW/ES ADM components and architecture and AMRF-C testbed technology. Demonstrate capability to support 4 beams/band transmit functions.
- Initiate final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware.

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FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the Shipboard EO/IR Closed Loop Self-Protection effort by final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware which includes a Mid-Wave IR (MWIR) camera operating in the 2-5 um wavelength spectral band.
- Initiate FNC EC Long Range Detection and Tracking. Capture and extend the prototype development that occurred under Advanced Electronic Sensor Systems for Missile Defense, this project delivers an affordable, open-architecture Digital Array Radar (DAR) single face Advanced Development Model.
- Initiate the Next Generation Airborne Electronic Attack effort by performing a threat assessment study.
- Initiate FNC EC Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Develop Partial Array consisting of high efficiency non-commercial off-the-shelf (COTS) transmitter element chains using wide band-gap semiconductors, mixed signal digital, RF, microwave, millimeter wave and associated passive components, exploiting Development & Implementation (D&I) advances in high power, high efficiency digital S- and X-band microwave amplifiers to reduce cooling and prime power needs, enabling affordable radar and EA solutions for CG(X), DD(X). Develop and demonstrate the technology for extending the digital domain further into the transmitter RF hardware, i.e., bringing the digital domain closer to the radiating element, enabling Navy systems to continue to exploit advancements in COTS computing capacity for signal generation and processing and require the activity to only develop the combined RF/digital hardware. Target cost reductions to enable ubiquitous deployment of advanced radiating systems with affordable development and procurement costs. This EC will take the lead for development of efficient, high power RF digital-microwave transmitter technology by exploiting new technologies such as Wide Band Gap (WBG) semiconductors for substantial savings of prime power requirements and topside weight and moment. This will provide a potential for smaller ships and reduced acquisition and life cycle costs.
- Initiate H-60 Tactical Commercial Data Link (TCDL) project.
- Initiate Low cost SATCOM-on-the Move array for Marine Corps.
- Initiate nested, coplanar array/ Modular Integrated Link Electronics System (MILES) design and integration.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete FNC EC: Long Range Detection and Tracking, S-Band Digital Array Radar Advanced Development Model.
- Initiate Integrated Digital Apertures and Array Radar System (IDAARS), a multi-function RF topside aperture

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prototype covering approximately 200MHz to 22 GHz and provide the appropriate control and synergy of the functionality such that the RF functions automatically support one another providing improved operational capability. Additionally, demonstrate reductions in size, weight, and power and cost (both acquisition and life cycle) by reducing the number of topside apertures needed for communication, electronic warfare, and some radar functions. A critical tenet of the prototype will be the demonstration of an open architecture so that not only can different companies supply the major components such as a given receive or transmit aperture, but even down to the subarray and lower component level throughout the life cycle to ensure continuing competition for maintenance and replacement parts.

- Initiate S-band Transmitter Element Chain development using high-efficient switching amplifiers to meet prime power constraints. Array efficiency impacts Size, Weight, and Power (SWAP). Expect substantial savings of prime power requirements, topside weight and moment, thus providing a potential for smaller ships and reduced acquisition and life cycle costs.
- Initiate X-band Transmitter Element Chain development using transversal distributed power digital-to-analog converter, mmWave GaN device and incorporating high-efficient switching amplifiers to meet prime power constraints. Conventional array architectures are cost prohibitive. Array efficiency impacts SWAP. Expect substantial savings of prime power requirements and topside weight and moment, thus providing a potential for smaller ships and reduced acquisition and life cycle costs.
- Initiate EA Shipboard Integrated Electronic Warfare Improvement Program (SEWIP) Linear Transmit Chain development using power digital-to-analog converters operating with wide bandwidth and high linearity. Device enables a bits-to-antenna transmit array with multiple simultaneous RF beams using affordable components to reduce acquisition and life cycle costs.

	FY 2006	FY 2007	FY 2008	FY 2009
ELECTRONICS AND COMMUNICATIONS TECHNOLOGIES	29,682	0	0	0

Beginning in FY 2007, the following projects previously reported within the ELECTRONICS and COMMUNICATIONS TECHNOLOGIES activity are aligned with the SEA SHIELD FNC EC, and have accordingly moved to the ADVANCED MULTI-FUNCTION RF TECHNOLOGY activity under this PE: S-Band Digital Array Radar (DAR), EA Techniques to Counter the Advanced Threat, Littoral Affordability, and Affordable Ground Based Radar.

FY 2006 Accomplishments:

- Continued development of Ultra High Frequency (UHF)/L Band Phased Array Antennas for Carrier Vessel Nuclear

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(CVN), to provide 16-20 Joint Tactical Radio System (JTRS) compliant communications beams within CVN Radar Cross Section (RCS) requirements. FY07 work will continue in PE 0603235N.

- Completed the integration and testing of the Precision Search & Track (PS&T)/Real Time Precision Surveillance Targeting Radar.
- Completed development of Next Generation Communications at Speed and Depth (NGCSD), 2400 bps throughput; effort transfers to Program Management of Warfare (PMW) 770 Submarine Integrated Antenna System (SIAS).
- Completed demonstration and performance optimization of the Integrated, Very High, Ultra High Frequency, L Band (IVUL) prototype antenna, meeting DD(X) RCS with -20 to -30 dB intermod products.
- Initiated and completed Airborne Communications Package and transition to FIRESOUL UAV (PMA-263), providing 3-beam TCDL out to greater than 80 nautical miles.
- Initiated development of High Altitude Airborne Relay and Router Package to deliver multi-beam relay/router and high altitude (>65,000ft) capability across UHF, VHF, L and Ku bands with > 200 nm footprint. Work was funded in PE 0602235N in FY05; FY07 work will continue under PE 0603235N.

FY 2007 Plans:

- No further efforts in this activity.

FY 2008 Plans:

- No further efforts in this activity.

FY 2009 Plans:

- No further efforts in this activity.

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:

PE 0204152N (E-2 Squadrons)

PE 0604307N (Surface Combatant Combat System Engineering)

PE 0601153N (Defense Research Sciences)

PE 0602271N (RF Systems Applied Research)

PE 0602123N (Force Protection Applied Research)

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PE 0603123N (Force Protection Advanced Technology)

PE 0602235N (Common Picture Applied Research)

PE 0603235N (Common Picture Advanced Technology)

PE 0602131M (Marine Corps Landing Force Technology)

PE 0603640M (USMC Advanced Technology Demonstration (ATD))

NON-NAVY RELATED RDT&E: Not applicable.

D. ACQUISITION STRATEGY:

Not applicable.

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PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

PROJECT TITLE: Congressional Plus-Ups

CONGRESSIONAL PLUS-UPS:

	FY 2006	FY 2007
ADVANCED LOW COST RADAR MODULE COOLING SYSTEM	0	1,345

This effort supports the Advanced Low Cost Radar Module Cooling System.

	FY 2006	FY 2007
ADVANCED WIDEBAND OPEN ARCHITECTURE RADAR SYSTEM	0	11,955

This effort supports Advanced Wideband Open Architecture Radar Systems.

	FY 2006	FY 2007
AN/SPS-67 C-BAND ACTIVE ARRAY RADAR (CBAAR)	12,210	16,408

FY 2006: This effort supported C-Band Transmit-Receive Module development and improvement.

FY 2007: This effort supports AN/SPS-67 C-Band Active Array Radar (CBAAR).

	FY 2006	FY 2007
APY-6 REAL TIME PRECISION TARGETING RADAR	1,915	1,992

FY 2006: This effort supported APY-6 Real Time Precision Targeting Radar delivery and testing.

FY 2007: This effort supports APY-6 Real Time Precision Targeting Radar.

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PROJECT TITLE: Congressional Plus-Ups

	FY 2006	FY 2007
COMMAND AND CONTROL ON THE MOVE NETWORK DIGITAL OVER THE HORIZON RELAY (CONDOR)	0	6,376

This effort supports the Command and Control on the Move Network Digital Over the Horizon Relay (CONDOR).

	FY 2006	FY 2007
COMMON AFFORDABLE RADAR PROCESSOR	6,512	6,774

FY 2006: This effort supported common affordable radar processor research by demonstrating the ability to form 16 simultaneous digital beams from 56 simulated radar receivers, and then process the beam data with commercial servers in an open architecture environment.

FY 2007: This effort supports the Common Affordable Radar Processor.

	FY 2006	FY 2007
COMMON RADAR SIGNAL PROCESSOR	0	2,889

This effort supports the Common Radar Signal Processor.

	FY 2006	FY 2007
HESS	1,341	1,494

FY 2006: This effort supported HESS research by testing the sub-ambient cooling approach at high power levels and improving a High Voltage GaAs X-Band Power Amplifier.

FY 2007: This effort supports the HESS project.

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PROJECT TITLE: Congressional Plus-Ups

	FY 2006	FY 2007
HIGHLY MOBILE TACTICAL COMMUNICATIONS	2,494	0

This effort supported the HMTC operational field demonstration.

	FY 2006	FY 2007
JOINT ELECTRONIC ATTACK UNMANNED VEHICLES	1,459	996

FY 2006: This effort demonstrated a versatile communications EA capability aboard a fielded Marine Corps UAV to show the ability to rapidly prosecute counter-communications missions in support of the Global War on Terror (GWOT).

FY 2007: This effort supports the Joint Electronic Attack Unmanned Vehicles project.

	FY 2006	FY 2007
OPEN ARCHITECTURE COMPUTER TEST BED	0	1,594

This effort supports the Open Architecture Computer Test Bed.

	FY 2006	FY 2007
POLYIMIDE MACRO ELECTROMECHANICAL SYSTEMS	0	1,096

This effort supports Polyimide Macro Electromechanical Systems.