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FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT:0603271N

PROGRAM ELEMENT TITLE: RF Systems Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2913 RF Systems Advanced Technology **		76,171	65,098	60,991	53,253	58,941	59,104	CONT.	CONT.
R9025 Multi-Function, Multi-Band, Multi-Beam Communications Antenna System (M3CAS)	0	4,262	0	0	0	0	0	0	4,262
TOTAL **		80,433	65,098	60,991	53,253	58,941	59,104	CONT.	CONT

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603270N, 0603238N, and 0603794N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Work in this Program Element is addressing technologies critical to enabling the transformation to network centric warfare which utilizes multiple, simultaneous and continuous communications/data links between platforms while simultaneously performing the functions of Electronic Warfare (EW) and radar surveillance. The Radio Frequency (RF) Systems Advanced Technology Program addresses RF technology for Surface and Aerospace Surveillance Sensors and systems, Directed Energy, Electronic Combat Sensors and Systems, RF Radio Communications Systems, Multi-Function (integrated surveillance/electronic combat/communications) RF concepts and Electric Warship. The program emphasizes near to mid-term technology transition opportunities by developing and demonstrating advanced RF Systems technologies that enable new options for increased Time Critical Strike, Missile Defense and Platform Protection, and Knowledge Superiority and Assurance Future Naval Capabilities (FNCs). RF Surveillance Technology developments emphasize advanced sensors and sensor 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, discrimination, target identification and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. RF Electronic Combat Technology developments emphasize passive sensors and active and passive RF countermeasure systems which exploit, and counter, a broad range of electromagnetic threats. Program focus is on maintaining perfect real-time knowledge of the enemy and of the Electronic Order of Battle (EOB). The program also addresses the threat of cruise missiles to deployed naval forces and precision identification and location of threat emitters. This includes the development of threat warning and self-protection technology for tactical aircraft for Tactical Air Directed Infrared Countermeasures (TADIRCM) technologies. Radio Communications Technology developments address critical naval communications technology

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deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on high-bandwidth, reliable interoperable communications at all levels of command and on technology to enable rapid and reliable utilization of government and commercial telecommunication assets worldwide. Advanced Multi-Function RF (AMRF) Technology emphasizes development, demonstration and transition of wideband, high performance RF apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams and front ends optimized to Navy-unique needs for reduced radar cross section, and significant reduction in the numbers of apertures required to provide RF Surveillance, RF Electronic Combat and RF Radio Communications functions on Navy Combatants. Advanced RF Systems Technology developments directly support the Department of Defense Joint Warfighter Science and Technology Plan and the Defense Technology Area Plans. Projects within this program element have attributes that focus on enhancing the affordability of warfighting systems.

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

JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduces technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 2001</u>	<u>FY 2002</u>	<u>FY 2003</u>
(U) FY 2002 President's Budget	**	76,876	
(U) Adjustments from FY 02 PRESBUDG:			
Congressional Increase: M3CAS		4,300	
Section 8123 Management Initiative Reduction		-717	
PBD 630 FFRDC		-26	
U) FY 2003 President's Budget Request:	**	80,433	65,098

**The Science and Technology (S&T) PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603270N, 0603238N, and 0603794N.

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PROJECT NUMBER: R2193

PROJECT TITEL: RF Systems Advanced Technology

Advanced Multi-Function RF (AMRF) Technology emphasizes development, demonstration and transition of wideband, high performance RF apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams and front ends optimized to Navy-unique needs for reduced radar cross section, and significant reduction in the numbers of apertures required to provide RF Surveillance, RF Electronic Combat and RF Radio Communications functions on Navy Combatants. Advanced RF Systems Technology developments directly support the Department Of Defense Joint Warfighter Science and Technology Plan and the Defense Technology Area Plans. Projects within this program element have attributes that focus on enhancing the affordability of warfighting systems.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

(U) (\$16,302) Surface and Aerospace Surveillance RF Systems Advanced Technology Thrust develops and demonstrates advanced RF surveillance sensors, processing technologies, and systems for transition into new and existing naval platforms. The Technology program focus is on providing the Navy with high performance affordable surveillance systems that are responsive to identified naval needs for real time situational awareness, long range target detection, discrimination, identification, tracking and targeting of air and surface threats in all operating conditions. Major drivers include sensor performance in complex target areas, Electronic Counter Measures (ECM), and adverse environmental conditions, including weather and background clutter conditions typical of littoral operations. The program includes: Advanced Airborne Early Warning (AEW) Radar system technology, including Ultra-High-Frequency (UHF) Electronically Steered Array (UESA) development and demonstration, for the Navy's E-2C aircraft; an affordable pod configured Precision Surveillance and Targeting (PS&T) Radar for the F/A-18 aircraft; and highly digitized large scale arrays for future surface combatants. In FY 2001 the program initiated development of PS&T Radar system technology in support of identified Navy Time Critical Strike needs. The PS&T technologies include electronically steered arrays, advanced waveform generators and algorithms to provide adaptive mode and operating characteristics in littoral operating environments. The program continued development and fabrication of the Ultra-High Frequency Electronically Steered Array (UESA) Advanced Technology Demonstration (ATD) unit which is form, fit and function compatible with the Navy's carrier based E-2C AEW aircraft. Fabrication of the ATD unit is approximately seventy five percent complete and on schedule for delivery to the Navy in the second quarter of FY 2002. The program completed the development and prototyping of the Tactical Air Directional Infrared Countermeasures (TADIRCM) system and conducted initial captive flight testing of the prototype TADIRCM system. (FY 2001 accomplishments were funded in PE 0603238N and PE 0603270N.)

(U) (\$24,607) Radio Communications RF Systems Advanced Technology Thrust develops and demonstrates new RF communications sub-system, and systems' technologies for integration into naval air, surface, sub-surface and ground

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platforms. The program focuses on RF communications technologies and systems that provide new enabling capability for network-centric operations, including high-bandwidth connectivity for mobile platforms/forces and interoperability with coalition/allied forces. Technologies pursued in this thrust are specific to naval operations and platforms and as such are not available from Commercial Off The Shelf (COTS) or other service sources without adaptation and tailoring for naval capability needs and applications. Advanced radio communications system technologies developed in this program element provide reliable, and enduring high data rate, two way radio communications between naval operational forces and all levels of command in all operating conditions and environments including electronic countermeasures. In FY 2001 the program completed development of a Very High Frequency (VHF), Ultra High Frequency (UHF)/L-Band Physical Layer Open Systems Interconnect (OSI) Reference Model to enable non-line of sight communications between Navy surface combatants and other battle force and theater warfighting elements, and subsequently initiated prototype hardware development. The program initiated development of an X/Ku-Band Physical Layer and an OSI Reference Model for an advanced dual frequency X/Ku-Band RF Communications Link. (FY 2001 accomplishments were funded in PE 0603794N.)

(U) (\$14,582) Advanced Multi-Function RF Concept (AMRF-C) technologies are needed to enable the integration of critical mission functions (Radar, Electronic Warfare and Communications) into a common set of RF apertures that operate efficiently over a broad spectral bandwidth. Significant reductions in the numbers of antennas required to support platform level RF Surveillance, RF Electronic Combat and RF Radio Communications functions are needed to improve combat system performance, reduce life cycle costs, and to reduce platform electromagnetic signatures resulting in significant increases in warfighting effectiveness and survivability. This phase of the AMRF-C testbed is specifically aimed at integrating communications/data links and EW functionality into common apertures such that multiple, simultaneous, independent RF beams are possible. This situation is in contrast to the objective of the Navy's multifunction radar (MFR, AN/SPY-3) acquisition program that uses earlier technology that provides only sequential radar beams. While most radar functionality can be accomplished with sequential beams due to the pulsed character of the radar surveillance waveform, this is totally unacceptable for communications/data links and electronic warfare that require continuous waveforms that cannot be accomplished with an architecture design for sequential pulsed mode operation. As a result the underlying AMRF-C architecture is significantly more complex than that for MFR with its sequential transmit and receive beams. The AMRF-C program is developing the required new architecture and associated unique electronics which include true time delay vice phase shift beam steering; ultra-high power, wide band-gap amplifiers; tunable filters, digital beam-forming, and ultra-high frequency direct digital synthesizers. In addition the open system architecture of AMRF-C utilizes proven middle-ware that provides modular software-defined functionality that has demonstrated the ability to enable affordable, rapid upgrades in response to the ever-changing threat environment. The AMRF-C program must next address technical issues such as electromagnetic interference; control of multiple, simultaneous, independent beams; and dynamic allocation/reconfiguration of the aperture. This technology is very applicable to future Naval systems such as DDX, Virginia Class Submarines, Cruiser Conversion, CVNX, JCCX, and AIEWS Increment II. The current AMRF-C program is scheduled to demonstrate the ability to simultaneously support many simultaneous transmit and receive

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communication/data link and electronic warfare beams in 2003. In FY 2001 the program continued development of both the High Band Multifunction Receiver and the Multifunction Radio Frequency (AMRF) High Band Transmitter units both critical elements of the Advanced Multi-Function RF Systems Technology Testbed. The program also continued development and initiated software build for the testbed System Resource Allocation Manager (SRAM). The SRAM subsystem when complete will function as the system controller where it will automatically, and on demand, adapt and schedule system operating characteristics resources in response to operational and environmental dynamics. Initial testing of the Aperture Beam Steering/Control and Signal Generator sub-systems was conducted. Design, fabrication, testing and characterization of the V1 Low Band Transmit Array output power and performance was completed in FY 2001. (FY 2001 accomplishments were funded in PE 0603270N, PE 0603238N and PE 0603794N.)

(U) FY 2002 PLAN:

- (U) (\$22,968) Surface and Aerospace Surveillance Advanced RF Systems program will initiate development of a flyable UESA antenna that is optimized for integration with the E-2C Radar Modernization Program (RMP) system. The flyable UESA subsystem design is specified to meet or exceed existing E-2C rotating antenna RF gain characteristics, while being electronically steered through the full 360 degree surveillance and track volume. The unit is also being designed and built to be fully compatible with the E-2C aircraft operating environment, avionics and flight control systems. The program continues development of a Precision Surveillance & Targeting (PS&T) radar system that can be implemented in a pod configuration for in-flight captive carry on a Navy F/A-18 aircraft. The PS&T advanced technology system will enable Naval F/A-18 and other strike aircraft to simultaneously execute surveillance, discrimination and geo-location/tracking of both stationary and moving ground targets in complex background clutter and electronic countermeasure environments. The UESA Advanced Technology Demonstration project completes in FY 2002 with a demonstration of the brassboard UESA system installed and operating from a land based tower. Development and demonstration of the TADIRCM technology will complete at the end of FY 2002.
- (U) (\$27,203) The Radio Communications RF Advanced Technology program designs and develops advanced technology that is ready for Naval acquisition programs. Advanced wireless communications and networked systems enable Navy and Marine Corps warfighters to achieve rapid, accurate, and consistent situational understanding using command and combat systems; and to plan and execute operations that are coordinated across all involved organizations and echelon levels, including coalition partners. Further, these technology efforts will provide basic system level components (antennas and networking) that are necessary for the network infrastructure, in order to support evaluation of network centric concepts within the Navy. The FY 2002 Radio Communications RF Advanced Technology program will initiate development of a K/Ka/Q-Band Physical Layer (OSI Reference Model) to aid in development of a wideband, electronically steered array for an advanced K/Ka/Q-Band RF Communications Link that supports up to three mega bits per second communications data rates between communication satellites and Naval Surface Combatants. This product will provide ship and submarine designers with the ability to incorporate antenna technology into the design of surface and subsurface platforms. The K/Ka/Q band array provides Naval combatants with the ability to access Wideband Gapfiller Satellites (WGS), MILSTAR and Commercial satellite constellations to support beyond line-

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of-sight connectivity needed for Network Centric Warfare. The Naval Battleforce Network (NBN), which is an organic network to enable Battle Groups (BG) and Amphibious Ready Groups (ARG) to provide local connectivity among their ships, emphasizes aerial communications relays, littoral mobile wireless networking, and composite routing. This area will continue development of an integrated VHF/UHF/L-Band aperture that is capable of merging five Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) functions into a highly integrated federation of antennas for initial application to Navy surface combatants; an X/Ku-Band electronically steered array with multiple, simultaneous transmit/receive beams to provide Tactical Common Data Link (TCDL) connectivity to theater assets; and an S-Band Receive Phased Array prototype which will begin testing this year and is expected to continue testing through fiscal year 2003. The S-Band receive phased array will provide Naval tactical forces with ready access to selected national assets.

- (U) (\$26,000) Multi-Function RF Concept Technology will initiate a Test Bed Integration and Preliminary Testing program of the AMRF-C Test Bed. It is continuing the integration and demonstration of: high band multi-function receiver system for AMRF; a beam former and signal generator with the high band AMRF subsystem; (construction and testing of the AMRF test bed receiver and digital beam former; and performance characterization tests of the low band transmit array and its isolation parameters at a laboratory field site.) The program will complete the design, development, evaluation and documentation of the system resource allocation manager software; and development and implementation of the realtime system network into the system technology testbed.

3. (U) FY 2003 PLAN:

- (U) (\$13,800) The Surface and Aerospace Surveillance RF Advanced Technology Thrust will continue development of UESA Radar technology for application to the E-2C RMP Integration and Airborne Demonstration. The UESA demonstration array is comprised of fifty-four UHF elements, co-aligned with 108 Identification Friend or Foe (IFF) L-band elements, integrated into an E-2C rotodome. This will provide the E-2C with full 360 degree electronic scanning in the azimuth dimension and fixed beam coverage for both UHF surveillance and IFF in the elevation dimension. The program will continue development of the pod configured airborne Precision Surveillance and Targeting Radar with emphasis on its performance in Time Critical Strike (TCS) operations against stationary and slow moving ground targets in complex clutter and electronic countermeasure environments. In FY 2003 elements of the Affordable Ground Based Radar (AGBR) move from PE 0603758N, 0603235N, 0602131M, and 0602235N into this program element. The AGBR project is developing enabling technologies such as light weight, high power, high efficiency wide band radio frequency systems technology for application to the USMC Multi-Role Radar System (MRRS) program. Agreements are in place with the MRRS program to transition the ONR AGBR technology to the MRRS program in Fiscal Year 2006.

- (U) (\$23,700) The Radio Communications RF Advanced Technology program designs and develops advanced technology that is ready for Naval acquisition programs. Advanced wireless communications and networked systems enable Navy and Marine Corps warfighters to achieve rapid, accurate, and consistent situational understanding using command and

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combat systems; and to plan and execute operations that are coordinated across all involved organizations and echelon levels, including coalition partners. Further, these technology efforts will provide basic system level components (antennas and networking) that are necessary for the network infrastructure, in order to support evaluation of network centric concepts within the Navy. The Radio Communications RF Technology Thrust will initiate development of an Extremely Low Frequency (ELF) on Hull Antenna development to improve submarine at-depth communications. The program is continuing development of: the Naval Battleforce Network (NBN), which is a network to enable Battle Groups (BG) and Amphibious Ready Groups (ARG) to provide local communications relays, littoral mobile wireless networking, and composite routing; advanced multi-frequency and multi-function electronically steered apertures covering the frequency bands of K/Ka/Q to provide Naval combatants with connectivity to MILSTAR, Wideband Gapfiller Satellite (WGS) and commercial satellites. The program is also conducting testing and evaluation of: an S-Band receive phased array, and an X/Ku-Band electronically steered array with multiple transmit/receive beams to provide Tactical Common Data Link connectivity to theater assets; and the integrated VHF/UHF/L-Band aperture that is capable of merging five Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) functions into a single multiple antenna for initial applications.

- (U) (\$27,598) The Advanced Multi-Function RF Technology Thrust will complete Integration and initial performance testing and characterization of the AMRF High Band testbed. The thrust will initiate preliminary demonstrations of multiple simultaneous communication/data link and electronic warfare receive and transmit beams and functions to evaluate test bed functionality and to quantify an initial set of performance metrics and characteristics such as: system efficiencies when executing simultaneous transmit/receive functions; system resource management to include system scheduling, conflict resolution and adaptive response to changing operations and environments; and determination of isolation characteristics and interference issues that occur when conducting simultaneous functions using shared/common system elements. Metrics resulting from the testbed evaluations will serve as design guidelines for Multi-function RF system architectures.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.
(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601152N (In-House Laboratory Independent Research)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602271N (RF Systems Applied Research)

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(U) PE 0602114N (Power Projection Applied Research)
(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0603123N (Force Protection Advanced Technology)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0603729N (Warfighter Protection Advanced Technology)
(U) PE 0603236N (Warfighter Sustainment Advanced Technology)

(U) NON-NAVY RELATED RDT&E:
(U) PE 0602702F (Command, Control and Communications)
(U) PE 0602204F (Aerospace Sensors)
(U) PE 0602782A (Command, Control and Communications (C³) Technology)
(U) PE 0602705A (Electronics and Electronic Devices)
(U) PE 0602270A (Electronic Warfare Technology)
(U) PE 0603270A (Electronic Warfare Technology)
(U) PE 0603270F (Electronic Combat Technology)

E. (U) SCHEDULE PROFILE: Not Applicable.

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CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 and FY 2002 whose efforts fall within the scope of this (restructured program), or which were appropriated in this program element:

Multi-Function, Multi-band, Multi-Beam Communications Antenna System (M3CAS)
Tactical Aircraft Directed Infrared Countermeasures (TADIRCM)

1. FY 2001 Congressional Plus-ups:

- (U) (\$4,794K), The Tactical Aircraft Directed Infrared Countermeasures (TADIRCM) effort focused on the successful completion of the live missile firing program. A QF-4 drone aircraft with a podded TADIRCM system onboard successfully protected the aircraft against an advanced surface-to-air missile and an advanced air-to-missile. TADIRCM's impressive demonstrated performance is building strong support towards the establishment of a FY04 systems Development Demonstration (SDD) program. (This plus up was appropriated in PE 0604216N and realigned to PE 0603270N.

2. FY 2002 Congressional Plus-ups:

- (U) (\$4,262), Multi-Function, Multi-Band, Multi-Beam Communications Antenna System (M3CAS) - Funds provided will enable the Navy's S&T RF communications programs that are developing multi-function, multi-band, multi-beam phased array apertures for Naval surface combatants to determine and address risk factors associated with platform integration and electromagnetic compatibility issues in the early stages of development. The M3CAS funding will also provide Navy developers and acquisition planners with engineering models for use in optimizing aperture placement aboard the host platform to maximize operational utility and effectiveness in all operating environments.

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