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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Communications, Command and Control, Intelligence, Surveillance & Reconnaissance (C3ISR)

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1998 ACTUAL	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
C3ISR	54,084	68,108*	68,823	70,272	72,726	76,111	77,904	79,762	CONT.	CONT.

*FY 1999 transfer during execution from PE 0605866N to correct budgeting error (+1,100)

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) supports future command, control, communications (C³) and intelligence, surveillance & reconnaissance (ISR) systems for surface, air and space platforms and ashore for Naval Warfare. C³ technology focuses on the delivery of critical, time sensitive, tactical information to decision makers for fusion and management of information between the warrior, command centers, and National Command Authorities. Technology developments include network Centric architecture and information infrastructure, intelligent information exploitation and retrieval, consistent tactical picture development, collaboration environments, and interactive decision support including continuous plan-execute cycles, and navigation. The major goal is to provide the Navy with the capacity to interconnect government and commercial telecommunication assets, worldwide, that is efficient and responsive to regional theater challenges and the National interest. Surface/Aerospace ISR technology emphasizes advanced sensor and processing systems for theater wide air and surface surveillance, battle group surveillance, real-time reconnaissance and ship self-defense. Major technology goals include increased long-range target detection and discrimination, precision track and positive target identification in complex countermeasure and adverse environmental conditions. Both C³ and ISR technologies directly support the Joint Warfighter Mission Areas and Areas of Precision Force (Strike Warfare) including Littoral Warfare, Combat Identification (ID), Joint Theater Missile Defense, and Information Superiority. Specifically: Precision Force efforts address technology issues in real-time targeting, long range target detection, track and engage and Battle Damage Assessment (BDA). Programs include mission planning, en-route C³, precision targeting, multisensor fusion, and temporal and spectral discrimination algorithms. Precision Force in the Littorals addresses issues in air and surface battlespace and develops technology for ship self-defense, cooperative engagement and power projection systems including ship-based and off-ship radar and electro-optic/infrared (EO/IR) sensors, connectivity and robust, enduring communications. ISR technology efforts address issues of precise target location and real-time targeting, counter-jamming and deception. Program includes multi-platform radar and (IR) sensors for detection,

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identification, tracking, BDA, and timely distribution of surveillance information to all levels of command. C³ efforts address Networked Operations supported by distributed collaborative battle management. Operational focus areas are littoral warfare, strike and operations other than war (OOTW) e.g. humanitarian assistance. This PE emphasizes sensors and C³ technology to provide Naval Warfighters with seamless, timely situational awareness of the total battlespace and indications and warning of threat operations and intentions.

(U) These efforts support the Joint Warfare Strategy "Forward... From the Sea". Programs are jointly planned in the Defense Technology Area Planning Process within the Department of Defense.

(U) Due to the sheer volume of work included in this PE, the programs described in the Accomplishments and Plans sections are only representative selections of the work included in this PE and not an exhaustive presentation.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications towards solution of specific Naval problems short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1998 ACCOMPLISHMENTS:

- (U) (\$20,430) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as ships and aircraft and cross cutting technologies that apply across platforms. Major drivers include affordability and sensor performance in complex target, Electronic Countermeasure (ECM) and adverse environmental conditions including operations in the littorals.
 - (U) Developed multi-band shipboard radar system architecture including design concepts for a multi-frequency band, electronically steered phased array to enable search, track and engage functions from a single topside

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radio frequency (RF) Aperture. This effort is also assessing effectiveness of adaptive waveforms for suppressing effects of clutter and ECM on system dynamic range. Addresses DD-21 needs to reduce topside signatures by reducing the number of RF apertures required for radar operations.

- (U) Fabricated scale model of voltage controlled diode affordable phased array radar for performance assessment. Cost of a shipboard four-face voltage controlled diode antenna array is estimated to be 20% of the cost of current active element, phase shifter steered arrays. Addresses Navy needs for affordable high performance radar antennas. Program was enabled by previous Small Business Innovation Research (SBIR) program investment.

- (U) Developed design for Millimeter Wave High Resolution Radar demonstration model to evaluate detection and precision track performance for short range, ship defense operations in countering high dynamic anti-ship missiles. Addresses Navy needs for precision fire control quality tracking and cueing of anti-ship missile defense engagement systems Program Executive Officer, Theater Air Defense (PEO-TAD, N091).

- (U) Developed scale model ultra high frequency (UHF) non rotating electronically scanned phased array that is form, fit and function with current Navy E-2C Aircraft rotodome antenna configuration. Identification Friend or Foe (IFF) antennas for 360° field of view (vice current 120 degree) are integral to the antenna and rotodome structure. Addresses PEO-T/PMA-231 needs for radar surveillance and tracking of cruise and theater ballistic missiles in littoral regions.

- (U) Initiated systems study to determine extent of upgrade to the Mountaintop experimental radar necessary to enable future technology feasibility demonstrations in theater ballistic missile and cruise missile defense scenarios. This study is being conducted in conjunction with Pacific Missile Range Facility staff to insure compatibility with range operations.

- (U) Developed compact UHF digital receiver for E-2C AN/APS-145 radar improvement program. Utilized Defense Advanced Research Projects Agency (DARPA) advances in Microwave Monolithic Integrated Circuit (MIMIC) technology to realize a high performance direct RF to digital receiver (that is less than one tenth the size and weight of current E-2C receiver). Addresses PEO-A/PMA-231 needs.

- (U) Established a program to develop airborne multi-mode radar technology to enable imaging of stationary and mobile land and sea targets from a single radar system. Technology needs of Navy AN/APS-137 (PMA-290) and Joint Surveillance Target Attack Radar System (JSTARS) are addressed.

- (U) Laboratory and field tested ultra wideband very high frequency (VHF/UHF) radar for concealed/buried target detection, location and imaging. Hyper resolution techniques have been developed to maximize image

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quality and to minimize false alarm. This program is coordinated with Defense Advanced Research Project Agency (DARPA), Army and the Defense Intelligence Agency.

- (U) Completed Joint Program with Air Force and DARPA to develop Automatic Target Recognition technology including algorithms to extract and correlate target electromagnetic and dimensional characteristics from high resolution radar profiles and imagery. Addressed needs identified by Joint Combat Identification Office (JCIDO), CNO-N66, for high confidence target identification systems that are insensitive to target aspect angle and dynamics. Technology planned for transition to United States Air Force (USAF) F-16 in FY1999.

- (U) Demonstrated high resolution, passive imaging millimeter wave radiometric sensor for covert, all weather strike targeting, target identification and battle damage assessment. The sensor produced clearly defined images of visibly obscured (Fog) ground structures and vehicles such as buildings, bridges and various trucks and armored vehicles. This demonstration sensor was enabled by millimeter wave focal plane technology developed by DARPA under the Technology Reinvention Program (TRP). Demonstration addressed Navy and Marine Corps needs for low probability of intercept sensors identified by the Office of the Chief of Naval Operations (N88) and the Commander in Chief Atlantic Fleet (CINCLANTFLT) and is also responsive to PEO-TAD needs for covert navigation in restricted waters.

- (U) (\$11,576) EO/IR TECHNOLOGY: The EO/IR technology investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and autonomous processing capabilities. The program emphasizes needs of major Navy air platforms for detection, acquisition, precision targeting and fire control handoff. Technologies such as multi-wavelength passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed.

- (U) Completed system design and architectural studies addressing deficiencies of scanned Infrared Search and Tracks (IRSTs) such as missed target detection due to atmospheric scintillation and need to mitigate ocean sun glint effects. This advanced staring infrared panoramic search and track sensor and signal processing technology uses spatial, temporal and spectral discriminates to detect subsonic and supersonic targets such as Anti Ship Missiles (ASMs) and TMBs while suppressing clutter (backlit clouds, surface reflections) and nuisance targets. The completed design incorporates DARPA-funded technology for high-performance 1024 x 1024 staring Focal Plane Arrays (FPAs). The Joint program with the United Kingdom Royal Navy and addressing PEO-TAD/SC needs for ship and TBM defense has been put on hold. The design concepts although not demonstrated have transitioned to PEO-TAD and NSWC-DD E&MD IRST program.

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- - (U) Completed hardware and software integration of real time multi-dimensional commercial off the shelf (COTS) signal processor with the ship two-color IRST, and transitioned to PEO-TAD and NSWC-DD for use in E&MD IRST program.
- (U) Developed compact dual-band airborne IRST sensor with active laser aperture for E-2C to enable long range detection and tracking of TBMs and cruise missiles (CMS). Laser development funded by Ballistic Missile Defense Organization (BMDO). Program addresses needs identified by the Fleet Commander In Chiefs, PEO-TAD and PEO-A for long range detection and precision track of TBM's and CM's.
- (U) Developed Hyper Spectral Infrared sensor jointly with USAF and Defense Airborne Reconnaissance Office (DARO) with greater than one hundred sub-bands in both the mid wave (3-5 microns) and long wave (8-12 microns) spectral bands and developed IR signal processing algorithms to recognize/exploit man-made target signatures relative to natural backgrounds and countermeasures in support of tactical and airborne reconnaissance, surveillance and strike warfare needs identified by Commander In Chief Pacific Fleet (CINCPACFLT) and N091.
- (U) Developed modeling and simulations to enable fusion of multiple wavelength EO passive and active sensor attributes. Incorporated worldwide threat, scene/terrain and environmental databases. Conducted analysis and simulation of sensor and operating characteristics in environments representative of worldwide conditions. Products of this development are being utilized by Government laboratories and industry to optimize sensor designs and architectures without incurring the cost of hardware and field tests.
- (U) (\$2,872) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platforms Combat System Architecture. The program emphasizes needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as processing architectures and algorithms to fuse, filter and correlate data and automated resource management procession are pursued.
- (U) Completed development of F/A-18 aircraft SUU-63A wing station configured receivers, processors and antennas to enable precision targeting of emitters at ranges beyond the defensive weapons systems. Addresses Fleet needs and those of NAVAIR-PMA 242 and PMA 265 for passive RF targeting for High Speed Anti-Radiation Missile (HARM).

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- (U) Developed/integrated encoded modulation waveforms into existing aircraft (AV-8B) targeting laser for laser interrogation of an IFF system. Implemented corresponding decoding logic into existing laser warning receivers to cue standard IFF response on own aircraft. Addresses Fleet and Chief of Naval Operations (CNO) N66 needs for positive Combat ID to eliminate/minimize fratricide during close air support operations.
- (U) Developed data fusion/resource management processing architecture in an interactive simulation to facilitate autonomous multi-sensor operation. Integrated models of current operational sensors (Radar, Electronic Support Measures (ESM), EO) into a multi-sensor test bed enabling evaluation and demonstration of emerging fusion and resource management processing technology without costly flight tests. Responds to Fleet requirements/needs for timely integration and dissemination of on-board and all source sensor data with automated data fusion and tactical decision aids for real time sensor optimization.
- (U) (\$1,835) COMMUNICATIONS NETWORKS: Continue development of technologies critical to performance and robustness of Naval Communications networks.
 - (U) Designed and tested prototype software for the high performance reliable multicast transport protocol and Quality of Service (QOS) enhancements to the Internet Protocol (IP). Coordinated via the Information Superiority Technology (IST) Panel of the Defense S&T Reliance.
 - (U) Installed the ATM networking testbed. Prepared test plans and procedures in coordination with French experts. Coordinated via IST Panel of the Defense S&T Reliance.
 - (U) Developed Domain Name Server for heterogeneous mobile networks. Coordinated with the DARPA Warfighters Internet program. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Analyzed the QOS Channel Allocation Protocol for throughput, delay and robustness.
- (U) (\$10,028) RADIO COMMUNICATIONS: Continued development of key communications technologies for air, ship and submarines.
 - (U) Conducted full-configuration at-sea testing of the compact low-profile buoyant cable submarine antenna.
 - (U) Developed the design software for the structurally-embedded, reconfigurable aircraft antenna array panel on a curved surface, and compared, with computed predictions. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Developed an improved modem for UHF line-of-sight communications employing bandwidth efficient modulations and adaptive equalization of the fading and multi-path maritime channel. Incorporated power

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management and control algorithms to achieve efficient use of available power resources. Coordinated via the IST Panel of the Defense S&T Reliance.

- (U) Adapted commercial code division multiple access (CDMA) wireless technologies to naval applications. Employed power management and control algorithms for improved network design. Coordinated via the (IST) Panel of the Defense S&T Reliance.

- (U) Based on at-sea experiments conducted with the National Aeronautics and Space Administration (NASA) Advanced Communications Technology Satellite (ACTS), developed framework for reception of Global Broadcast Service (GBS) on naval ships and aircraft.

- (U) (\$5,714) COMMAND SUPPORT: This program develops and demonstrates software components and technologies that enable the Navy's concept of Network-Centric Warfare and the Joint Chiefs Joint Vision 2010. The focus is on militarily-unique information processing technologies that enable information dominance through vastly improved speed of command. Particular emphasis is directed to issues involving the ability of geographically distributed Naval decision-makers to collectively generate and perceive a Common Tactical/Operational Picture, and to jointly plan and monitor military missions. All of the research efforts recognize the important role of COTS software components and standards, and consequently they focus on maximizing the integration of such software into software functionality for Naval applications.
 - (U) Demonstrated support of the Common Operational Picture/Common Tactical Picture (COP/CTP) and mission planning, demonstrated an intelligent agent architecture and agents for the smart retrieval of tactically useful information (e.g. an agent for retrieving weather at a planned landing zone).
 - (U) Completed prototype and demonstrated an object oriented database management architecture using real time interface mechanism to access hybrid databases (flat files, relational, or object oriented) in a distributed real time information system. Real-time extensions submitted to the Object Management Group for incorporation as an international computing industry standard.
 - (U) Transitioned collaborative environment technology integrating COTS groupware and collaborative tools to support day-to-day ops, etc. to Space and Naval Warfare Systems (SPAWAR) (PE 0603794N).
 - (U) Initiated development of an Element Level Strike Planner using collaborative and distributive technology that will integrate operations of a strike mission plan from receipt of the Air Tasking Order to passing and briefing the completed plan to the Commanding Officer. Jointly funded with N88 and N63.

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- (U) In support of information system security, developed a formal model for protecting against data storage spoofing in large scale systems. Implemented an integrity cluster controller for combating malicious software attacks.

- (U) (\$1,629) NAVIGATION: Continued development of key navigation technologies for air, ship and submarines.
 - (U) Performed concept demonstration of the candidate signal structure for reduced Global Positioning System (GPS) vulnerability.
 - (U) Analyzed measured reductions in the dead-band lock-in for the quantum-well mirror ring laser gyro technology.
 - (U) Completed laboratory evaluation of high performance fiber-optic gyro (FOG) Advanced Development Model I for submarine applications and transitioned to the Navy Special Projects Office (SP-24).
 - (U) Developed and tested the high power fiber-optic light source for high performance FOGs.
 - (U) Identified techniques for data compression and bulk processing applicable to fast processing of GPS signals.

3. (U) FY 1999 PLAN:

- (U) (\$32,342) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as Ships and aircraft and cross cutting technologies that apply across platforms. Major drivers include affordability and sensor performance in complex target, ECM and adverse environmental conditions including operations in the littorals.
- FY 1999 funding for this thrust includes an \$11.0M Congressional add-on for UHF Electronically steered Array development and for Kauai, Hawaii Mountain Top facility capability improvements. This Congressional add-on is for FY 1999 only.
 - (U) Install multi-band, flexible waveform, shipboard radar sensor at Wallops Island for performance and operational utility assessments against representative targets in varying environmental clutter and sea state conditions. Assessments jointly conducted with PEO-TAD/SC.
 - (U) Continue development of adaptive waveforms for multi-band shipboard radar to maximize detection and track performance in complex target and multi-path conditions and to minimize system dynamic range and analog-to-

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digital converter requirements. Addresses PEO-TAD/SC and N-86 needs for continuous track in severe multi-path and clutter conditions.

- (U) Integrate scale model voltage controlled diode array with test bed radar system to develop performance versus cost trade-off metrics. Responds to Navy needs for affordable high performance RF apertures. Joint program with DARPA.

- (U) Continue development of Millimeter Wave High Resolution Radar Demonstration Model for close in anti-ship cruise missile (ASCM) tracking. Incorporate High Power source developed by the Electronics program under PE 0602234N.

- (U) Characterize performance of scale model UHF electronically scanned array in static chamber testing and at the experimental radar facility at Pacific Missile Range Facility (PMRF), Kauai, Hawaii. Compare overall performance to existing E-2C TRAC-A, and ADS-18 antenna systems. Conduct E-2C integration studies to include electromagnetic compatibility determinations. This development addresses technology needs identified by CNO-N88, PEO-A and PMA-231 for multi-target tracking of theater ballistic and cruise missiles and for 360 degree continuous (IFF) capability.

- (U) Complete technology development of UHF digital receiver and characterize performance in preparation for field testing at the Mountaintop Radar Facility in Kauai, Hawaii.

- (U) Flight test concealed/buried target detection ultra-wideband radar to quantify target detection and image qualities in high false alarm conditions. DARPA and Army will participate in flight test effort.

- (U) Integrate test bed model of airborne multi-mode radar system into test aircraft for performance evaluation against small seaborne craft and moving and stationary ground targets. DARPA, Air Force (Wright Laboratories) and JSTARS program will participate in evaluation.

- (U) Continue joint program with Air Force and DARPA to develop automatic target recognition algorithms in support of Tri-Service needs for long range identification of stationary and slow moving ground targets.

- (U) Congressional Plus Up: Integrate UHF Electronically Steered Array in Kauai, Hawaii Mountain Top Test Facility. Effort includes improvements to the facilities experimental radar and will establish connectivity to the Maui High Performance Computing Center.

- (U) (\$11,568) EO/IR TECHNOLOGY: The EO/IR technology investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and autonomous processing capabilities. The program emphasizes needs of major Navy air platforms for detection, acquisition, precision targeting and fire control

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handoff. Technologies such as multi-wavelength passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed.

- (U) Integrate dual band airborne IRST sensor into a fleet configured E-2C aircraft for aircraft compatibility and performance evaluation. Optical aperture to enable insertion of BMDO funded laser sensor when sufficiently mature is included. This technology addresses needs for long range detection and tracking of Theater Ballistic Missiles identified by PEO TAD/SC and PEO-T.

- (U) Continue development of target discrimination and recognition algorithms to distinguish unique characteristics of man made objects relative to naturally occurring background clutter.

- (U) Continue joint program with Air Force and DARO to develop Hyper-spectral infrared sensors for Naval airborne Intelligence, surveillance and reconnaissance missions. Addresses needs identified by PMA-290 and PMA-265.

- (U) Continue modeling and simulation to optimize sensor operating characteristics and fusion of multi-wavelength EO passive and active sensor attributes. Develop cueing and control processing strategies to enable rapid hand-off of precision fire control data to on and off-board engagement systems.

- (U) Integrate multi-function electro-optic sensor technology completed in FY 98 into a distributed aperture infrared sensor system (DAIRS) specifically for the Joint Strike Fighter (JSF). This development addresses the JSF program office needs for passive infrared sensors to provide continuous situational awareness and missile warning. This development is coordinated with the Air Force within the JSF program office and within the Defense Reliance Sensors, Electronics and Battlespace Environments Panel.

- (U) Initiate joint program with DARPA and PMA-290 to develop and demonstrate Hyperspectral Electro-Optical Imaging technology on the EP-3 aircraft. Technology development emphasizes high resolution, multiband imaging sensor and algorithms for target detection and confirmation. Initial plans for insertion of this technology is for EP-3 with follow-on application to F-18F shared reconnaissance POD (SHARP). This effort addresses needs identified by CNO-N88 and PEO-T for real time situational awareness, precision targeting and battle damage assessment.

- (U) (\$2,768) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platforms Combat System Architecture.

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The program emphasizes needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as processing architectures and algorithms to fuse, filter and correlate data and automated resource management procession are pursued.

- (U) Transition targeting avionics sensor technology to PMA 242 to provide precision targeting capabilities for U.S Navy and (HARM) capable International aircraft.
- (U) Demonstrate laser encoded IFF on AV-8B and F/A-18 aircraft at CNO-N66 sponsored All Service Combat ID Evaluation Team (ASCIET) trials with follow-on evaluation by North Atlantic Treaty Organization (NATO) Atlantic Council 243 Defense Research Group member Nations.

(U) Integrate Data Fusion/Resource management processing algorithms into the SPY-1 radar at the Aegis Combat Systems Center and conduct ground system characterization and effectiveness assessments during theater ballistic missile tracking exercises. Addresses PEO TAD/SC needs for sensor resource management technology.

(U) Initiate system studies for the E-2C aircraft to define integrated multisensor architecture to include tactical data link and the cooperative engagement capability (CEC) system. This effort responds to needs identified by CNO-N88 and PMA-231 for detection, discrimination, fire control quality tracking and engagements of missile threats.

- (U) (\$1,809) COMMUNICATIONS NETWORKS: Continue development of technologies critical to performance and robustness of Naval Communications networks.
 - (U) Test and analyze the prototype software for the high performance reliable multicast transport protocol and the QOS enhancements to the Internet Protocol (IP). This work extends COTS-based reliable multicast protocols to various military applications. Present the results to the Internet Engineering Task Force (IETF) for consideration in the next generation standards-track protocols. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Incorporate the enhanced transport and IP prototype software in the ATM network testbed and test their performance relative to existing protocols. Borrow Asynchronous Transfer Mode (ATM) machines from France for performance testing. Conduct tests employing different ATM machines to determine quality of performance and interoperability. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Investigate technical issues related to ATM use, such as signaling, interoperability robustness, and ability to support QOS at the application layer. Military use of ATM switches requires adaptation to RF media and is not limited to fiber-optic wires. Coordinated via the IST Panel of the Defense S&T Reliance.

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- (U) Develop intelligent local agents for heterogeneous mobile network management. Coordinated with the DARPA Warfighter Internet Program. Coordinated via the IST Panel of the Defense S&T Reliance.

- (U) (\$10, 600) RADIO COMMUNICATIONS: Continue development of key communications technologies for air, ship and submarines. FY 1999 funding for this Thrust includes \$1.0M Congressional add-on for development of Hybrid Wireless Fiber Communications Technology. Add-on is for FY 1999 only.
 - (U) Conclude the residual noise tests of the on-hull extremely low frequency (ELF) submarine antenna. This development provided first time capability for submarines to receive ELF transmissions without having to deploy a long trailing wire.
 - (U) Analyze data from the sea tests of the low profile buoyant cable submarine antenna. Perform comparative at-sea testing with DARPA buoyant-cable array design. This development enables up to order of magnitude increase in data rate with UHF operation at speed and depth.
 - (U) Complete development of the structurally-embedded, reconfigurable aircraft antenna array reconfiguration using optically activated switches. Structural embedment of antenna arrays reduces life cycle costs and radar cross-section. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Conduct laboratory and field tests of the improved modem for UHF line-of-sight ship communications. Compare results with expectations, and define further improvements as needed in the modem design and the power management algorithms. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Demonstrate the use of Code Division Multiple Access (CDMA) technologies in Navy tactical networks. CDMA requires adaptation from commercial networks to mobile military networks that require low probability of intercept/detection. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Develop Mechanically Assisted Phased Array (MAPA) antenna for the Ultra-Small Aperture Terminal (USAT) capable of GBS reception on board Navy ships and aircraft. Demonstrate use of back-channel connectivity to the GBS. Coordinated via the IST Panel of the Defense S&T Reliance.
 - (U) Congressional Plus-Up: Initiate investigation of hybrid fiberoptic/wireless communications systems. Coordinated via the IST Panel of the Defense S&T Reliance.

- (U) (\$5, 552) COMMAND SUPPORT: This program develops and demonstrates software components and technologies that enable the Navy's concept of Network-Centric Warfare and the Joint Chiefs Joint Vision 2010. The focus is on militarily-unique information processing technologies that enable information dominance through vastly improved
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speed of command. Particular emphasis is directed to issues involving the ability of geographically distributed Naval decision-makers to collectively generate and perceive a Common Tactical/Operational Picture, and to jointly plan and monitor military missions. All of the research efforts recognize the important role of COTS software components and standards, and consequently they focus on maximizing the integration of such software into software functionality for Naval applications.

- (U) In support of the Common Operational Picture/Common Tactical Picture (COP/CTP), continue development of software agents for intelligent data exploitation and retrieval. Specifically, implement a video abstract agent and web-based agents; develop a cooperative query capability; and test inter-agent architecture operation.

- (U) In support of COP/CTP, continue efforts to develop a real-time static scheduling service; advance the real-time operating mechanisms; define the real-time prototype environment to support distributed nodes; and integrate real-time mechanisms to support distributed collaboration.

- (U) In support of COP/CTP, evaluate the Covariance Intersection approach as a method to fuse data in a distributed environment.

- (U) Continue the development of collaborative environment tools specifically incorporating intelligent agent technology. Determine if the existing collaboration technology will support tactical environments and , if not, what modifications are required.

- (U) Advance decision support technologies through the development of case-based plan authoring and advanced use interfaces; implement intelligent agents into existing real-time execution decision support; develop common representation and interaction between planning and monitoring support capabilities.

- (U) In support of Network Operations, define the requirements and design specifications for Adaptive Rules of Engagement. Conduct user experiments with collaboration and decision support capabilities in coordination with SPAWAR and the Sea-Based Battle Lab (USS Coronado). Incorporate collaborative environment and execution monitoring capabilities into Extending the Littoral Battlespace (ELB) ACTD 1999 Demo.

- (U) (\$1,814) NAVIGATION: Continue development of navigation technologies for air, ship and submarines.
 - (U) Compare quantum-well mirror ring laser gyro measurement results with conventionally designed ring laser gyros. This development promises to eliminate mechanical dithering and make ring laser gyros more producible and affordable.
 - (U) Investigate use of pseudolites for acquiring ranging in addition to timing data using GPS signals. This development would lower the vulnerability of GPS users to enemy jamming.

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- (U) Apply modern digital signal processing technologies to the design and development of next generation Global Positioning System (GPS) receivers for improved anti-jam protection.
- (U) Test the Advanced Development Model II of the high performance fiber-optic gyro and transition to the Navy Special Project Office (SP-24). This development enables replacing the ESGN (Electrostatic Suspended Gyro Navigator) presently deployed on submarines with more affordable fiber-optic gyro navigators.
- (U) Integrate advanced electronics into strategic submarine navigation systems to reduce dependence on diminishing source of supply for older componentry.

- (U)(\$900) STRATEGIC SYSTEMS TECHNOLOGY: The objective of the Strategic System Sustainment project is to develop and demonstrate technologies in the areas of Missile Flight Science, Submarine Navigation, and Underwater Missile Launch to sustain these strategic capabilities that will (1) reduce the reliance on unique materials and processes, (2) reduce the reliance on human-expertise intensive processes, and (3) reduce the cost of maintaining these systems.
 - (U) Assess the existing missile flight science design and analysis codes for integration in to a platform-independent architecture.
 - (U) Develop Underwater Launch systems architecture.
- (U)(\$755) Portion of extramural program reserved for Small Business Innovative Research assessment in accordance with 15 USC 638.

4. (U) FY 2000 PLAN:

- (U) (\$22,193) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as Ships and aircraft and cross cutting technologies that apply across all platforms. Major drivers include affordability and sensor performance in complex target, ECM and adverse environmental conditions including operations in the littorals.

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- (U) Implement adaptive waveforms into Multi-band shipboard radar test bed and assess detection, tracking and dynamic range performance in complex countermeasure, clutter and multi-path environments. Addresses PEO-TAD/SC and N-86 needs for continuous fire quality tracking in severe countermeasure and clutter environments.
- (U) Initiate laboratory and field evaluation of High Power Millimeter Wave Radar Demonstration Model. Tracking quality and consistency will be evaluated against a variety of representative targets and countermeasure environments. Jointly conducted with the Electronics program under PE 0602234N.
- (U) Transition UHF Electronically Steered Antenna (UESA) array to Advanced Technology Demonstration (ATD) program, PE 0603792N. ATD endorsed and supported by OPNAV N-88 and COMNAVAIRSYSCOM PMA-231 in the near term and to the Common Support Aircraft in the mid-long term.
- (U) Integrate UHF Digital Receiver into the improved Mountaintop experimental Radar at PMRF, Kauai, Hawaii. Technology supports the UESA ATD and scheduled to transition to PMA-231 E-2C Radar Modernization Program (RMP) in FY-2001.
- (U) Complete flight test characterization of the Concealed Target Detection/Ground Penetrating Ultra Wideband Radar. This project is coordinated with the Defense S&T Reliance Sensors, Electronics and Battlespace Environments (SEBE) Panel.
- (U) Conduct initial flight measurements of the airborne Multi-Mode Radar system to characterize performance against ground targets in all operating regimes (moving, stationary). Jointly conducted with DARPA, USAF Wright Laboratories and the JSTARS program.
- (U) Continue joint program with Air Force and DARPA to develop automatic target recognition algorithms and signal processing in support of joint Warfighter and Tri-Service needs for long range identification of stationary and slow moving ground targets. Coordinated with Defense Reliance SEBE Panel.

- (U) (\$12,584) EO/IR TECHNOLOGY: The EO/IR technology program investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and processing capabilities. The program emphasizes needs of major Navy air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as multi-wavelength passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed.

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- (U) Complete in flight evaluation of the dual band (IRST) on a fleet E-2C aircraft participating in TBM detection and tracking exercises. This effort responds to stated needs of PEO TAD/SC and PEO-T for long range detection and precision tracking of TBMs. Jointly coordinated with the Air Force via Defense Reliance SEBE Panel.
 - (U) Integrate BMDO funded eye safe laser sensor into dual band airborne E-2C IRST for sensor compatibility and performance evaluations. Responds to Joint Theater Air and Missile Office needs for long range, precision tracking of TBMs.
 - (U) Continue development of target discrimination and recognition algorithms to distinguish unique characteristics of man made objects relative to naturally occurring background clutter.
 - (U) Continue modeling and simulation to optimize sensor operating characteristics and fusion of multi-wavelength passive and active EO sensor attributes. Develop and optimize sensor cueing and control processing strategies to enable rapid hand-off of precision fire control information to on- and off-board engagement systems.
 - (U) Transition Distributed Aperture Infrared Sensor (DAIRS) to (ATD) project as part of Multifunction Infrared Distributed Aperture System (MIDAS) under PE 0603792N. This technology is identified as a critical element of the Joint Strike Fighter roadmap for situational awareness and missile warning.
 - (U) Continue joint program with DARPA and PMA-290 to develop Hyperspectral Imaging sensor and processing for demonstration on the EP-3 aircraft. This effort addresses needs identified by CNO-N88 and PEO-A for real time situational awareness, precision targeting and battlespace assessment.
 - (U) Initiate development of laser and laser identification image profiling, leveraging DARPA developments in high frame rate Focal Plane Arrays to provide Navy and Marine Corps platforms with real-time long-range target discrimination and identification capability.
- (U) (\$3,407) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platforms Combat System Architecture. The program emphasize needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as processing architectures and algorithms to fuse, filter and correlate data and automated resource management procession are pursued.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Communications, Command and Control, Intelligence, Surveillance & Reconnaissance (C3ISR)

- (U) Complete flight test of the laser encoded IFF system on AV-8B and transition to the US Marine Corps program for Combat Identification. This effort responds to needs identified by Marine Corps and the Joint Combat Identification Office for positive combat ID to eliminate/minimize fratricide during close air support operations.

(U) Continue evaluation of Radar Resource Management processing algorithms in SPY-1 Radar at Aegis Combat Systems Center, Wallops Island, VA. This effort responds to needs identified by PEO TAD/SC for long range detection, discrimination and continuous tracking of theater ballistic missiles.

(U) Evaluate multi-sensor integration and data fusion algorithms in the E-2C aircraft Sensor Integration Laboratory and assess operational effectiveness improvements in Theater Air and missile defense operating environments. Responds to needs identified by the Fleet, Program Executive Officer, Tactical Aircraft Programs (PEO-T) for timely integration and dissemination of on and off board sensor information in all operating scenarios.

- (U) (\$3,509) COMMUNICATIONS NETWORKS: Continue development of technologies critical to performance and robustness of Naval Communications networks.
 - (U) Continue development of key communications network technologies for air, ship and submarines necessary for network-centric warfare.
 - (U) Evaluate the performance of the new reliable multicast and IP Quality of Service (QOS) protocols. Make analytic results available to the IETF in order that the commercial standard is compatible with military applications. Coordinated with the IST Panel of the Defense S&T Reliance.
 - (U) Conduct performance and interoperability testing of different ATM switches over the high speed ATM testbed employing the new reliable multicast and IP QOS protocols. Coordinated with the IST Panel of the Defense S&T Reliance.
 - (U) Evaluate simulation results of wireless, mobile network performance in relation to projected needs of military applications. Transition results to the INSC (Interoperable Networks for Secure Communications) 6.3 program to enable test/demonstration for coalition warfare. Coordinated with the IST Panel of the Defense S&T Reliance.
- (U) (\$10,573) RADIO COMMUNICATIONS: Continue development of key communications technologies for air, ship and submarines.

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- (U) Investigate CDMA links as back channel for GBS, employing very small aperture terminals appropriate for small craft use.
- (U) Transition the low-profile buoyant cable antenna enhancement to 6.3 Advanced Technology Development.
- (U) Transition the on-hull extremely low frequency (ELF) antenna to the Submarine Integrated Antenna System (SAIS) 6.4 project within PMW-173.
- (U) Develop technologies to enable large aperture multiple frequency band, multiple function antennas for current and future Navy attack submarines. Coordinated via the IST panel of the Defense S&T Reliance.
- (U) Transition the improved modem technology for UHF line-of-sight communications to the Joint Tactical Radio System (JTRS). Coordinated via the IST Panel of the Defense S&T Reliance.

- (U) Incorporate the Mechanically Assisted Phased Array (MAPA) antenna as part of Ultra-Small Aperture Terminal (USAT). Test and evaluate performance of MAPA antenna on different naval platforms. Coordinated via the IST Panel of the Defense S&T Reliance.

- (U) (\$9,107) COMMAND SUPPORT: This program develops and demonstrates software components and technologies that enable the Navy's concepts of Network-Centric Warfare and the Joint Chiefs Joint Vision 2010. The focus is on militarily-unique information processing technologies that enable information dominance through vastly improved speed of command. Particular emphasis is directed to issues involving the ability of geographically distributed Naval decision-makers to collectively generate and perceive a Common Tactical/Operational picture, and to jointly plan and monitor military missions. All of the research efforts recognize the important role of Commercial-off-the-Shelf software components, and consequently they focus on maximizing the integration of such software into software functionality for Naval applications.
 - (U) In support of (COP/CTP), continue development of intelligent agent technology to provide agent-based user profiling. Transition agent architecture to DISA GCCS. Integrate visualization basic research efforts into COP/CTP. Apply spatial database techniques for correlating covariance intersection estimates for corresponding entities to enhance consistency across different tactical pictures. Initiate effort on developing techniques to enhance real-time picture with non-real-time information.
 - (U) Develop initial prototype for a tactical collaborative environment to use during Littoral Warfare.

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- (U) In support of continuous planning-execution cycle, continue advances in a case-based reasoning plan authoring tool; develop a prototype Dynamic Resource Allocation capability to support real-time retargeting situations; develop an initial prototype augmenting the COP/CTP with an intelligent decision support system incorporating multiple interacting views of status, plans and predicted effects, e.g. map-based, pert-chart.
-
- (U) In support of Network Operations, investigate the process and issues associated with Rules of Engagement at all echelons of control starting with the National Command Authority (NCA) through the CINCPAC to the Battle Group to the individual Support Element Weapon System.
- (U) Identify requirements and functional building blocks of a CINCPAC HQ21 Architecture with the goal of developing a facility for test and evaluate of COTS software in a military operational context
- (U) (\$3,950) NAVIGATION: Continue development of key navigation technologies for air, ship and submarines.
 - (U) Transition the high performance fiber-optic gyro, Advanced Development Model-II to the Director, Navy Strategic Systems Project (SP-24).
 - (U) Perform laboratory proof-of-concept demonstration of the next generation digital GPS receiver for anti-jam performance.
 - (U) Develop advanced technologies that reduce the vulnerability of GPS to jamming and spoofing.
 - (U) Transition the quantum-well mirror ring laser gyro technology to Navy tactical missiles and ring laser gyro manufacturers.
 - (U) Develop the atom interferometer gravity gradiometry technology to achieve sensitivity of 0.1 E/(Hz)^{1/2}.
- (U) (\$3,500) STRATEGIC SYSTEMS TECHNOLOGY: The objective of the Strategic System Sustainment project is to develop and demonstrate technologies in the areas of Missile Flight Science, Submarine Navigation, and Underwater Missile Launch to sustain these strategic capabilities that will (1) reduce the reliance on unique materials and processes, (2) reduce the reliance on human-expertise intensive processes, and (3) reduce the cost of maintaining these systems.
 - (U) Develop first order methodologies for drag reduction, nuclear survivability, and solid motor ignition codes for the missile flight science design and analysis tool.
 - (U) Develop first order electronic database for Underwater Missile Launch tool.

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PROGRAM ELEMENT TITLE: Communications, Command and Control, Intelligence,
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B. (U) PROGRAM CHANGE SUMMARY:

	FY 1998	FY 1999	FY 2000
(U) FY 1999 President's Budget	54,814	66,133	68,403
(U) Appropriated Value.		64,033	
(U) Adjustments from FY 1999 PRESBUD.	-730	+1,975	+420
(U) FY 2000 President's Budget	54,084	68,108	68,823

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: FY 1998 adjustment reflects actual update adjustments (-730). FY 1999 adjustments reflect Congressional Undistributed Reductions (-525), Congressional Cut Strategic Sustainment (-8,000), Congressional Cut General Reduction (-5,000), Comparability Adjustments for FY00 (+3,500), Congressional Adds for Hybrid Wireless Fiber Comms (+1,000) and UESA Radar (+11,000). FY 2000 reflects minor program adjustments (+614), Navy Working Capital Fund adjustments (+559), Civilian Pay Rates (+242), and Non-Pay Inflation (-995).

(U) Schedule: Not applicable.

(U) Technical: Not applicable

C. (U) OTHER PROGRAM FUNDING SUMMARY:

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(U) RELATED RDT&E: This program adheres to Defense Science and Technology Reliance Agreements with oversight provided by the JDL. Work in this PE is related to and fully coordinated with efforts in the following PEs:

(U) PE 0602702F (Command, Control and Communications)

(U) PE 0602204F (Aerospace Avionics)

(U) PE 0602782A (Command, Control and Communications (C³) Technology)

(U) PE 0602204F (Aerospace Avionics)

(U) PE 0602709A (Night Vision Technology)

D. (U) SCHEDULE PROFILE: Not applicable.

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