FY 2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2006
Exhibit R-2

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
COMMON PICTURE APPLIED RESEARCH	100,205	106,391	68,352	72,732	72,115	73,097	72,926

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Work in this project examines technologies that enable the transformation to network centric warfare, which relies on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive FORCEnet S&T investments. The focus is S&T enablers that provide decision making and mission execution to achieve battlespace superiority. The project seeks to develop hardware and software technologies that (1) identify and integrate informational content from multi-media sources including images, and intelligence sources; (2) integrate massive amounts of information; and (3) provide automatic correlation, fusion, and insight to support user-cognitive processes. Particular emphasis will be placed on automating the association of objects and events in the battlespace and automatically transforming this information into actionable knowledge (e.g., indications and warnings of intent). In current and future operational environments such as Global War on Terrorism (GWOT) and Maritime Domain Awareness (MDA), warfighters require technologies evolved to support information needs regardless of location and consistent with the user’s level of command or responsibility and operational situation. Net-centric operations include communications and information assurance capabilities to enable all-source data access, multi-source processing, and tailored dissemination to C2 and ISR users across the network. The operational benefits sought are an increased speed, accuracy and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority. Technologies emphasized provide warfighters with a robust, secure, mission responsive network; integrated information leading automated courses of action; and presentation of knowledge to speed understanding. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

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This program explores and demonstrates technologies that enable options for FORCEnet, Sea Shield, and Sea Strike pillars. This program element contains investments in the following FORCEnet, Sea Strike and Sea Shield enabling capabilities: Hostile Fire Detection and Response, Next Generation Command, Control and Decision Support, Combat ID Information Management of coordinated Electronic Surveillance, Combat ID in the Maritime Domain to Reveal Contact Intent, Automated Control of Large Sensor Networks, and Real-Time Long Range Air Defense Combat ID in Support of Early Engagement. In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet, “Persistent Intelligence, Surveillance, and Reconnaissance,” “Time Sensitive Strike,” “Sea Based Information Operations,” “Sea Strike” Ship-to-Objective Maneuver, and “Sea Shield” Theater Air and Missile Defense.

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:

	FY 2005	FY 2006	FY 2007
FY 2006 President's Budget Submission	102,107	57,693	63,141
Congressional Action	0	49,650	0
Congressional Undistributed Reductions/Rescissions	-78	-952	0
Execution Adjustments	-414	0	0
FY 2005 SBIR	-1,410	0	0
Program Adjustments	0	0	-5,284
Program Realignment	0	0	10,515
Rate Adjustments	0	0	-20
FY 2007 President's Budget Submission	100,205	106,391	68,352

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:
Performance metrics are discussed within the R2a.

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BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602235N PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH
PROJECT TITLE: COMMON PICTURE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
COMMON PICTURE APPLIED RESEARCH	58,735	56,741	68,352	72,732	72,115	73,097	72,926

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Work in this project examines technologies that enable the transformation to network centric warfare, which relies on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive FORCEnet S&T investments. The focus is S&T enablers that provide decision making and mission execution to achieve battlespace superiority. The project seeks to develop hardware and software technologies that (1) identify and integrate informational content from multi-media sources including images, and intelligence sources; (2) integrate massive amounts of information; and (3) provide automatic correlation, fusion, and insight to support user-cognitive processes. Particular emphasis will be placed on automating the association of objects and events in the battlespace and automatically transforming this information into actionable knowledge (e.g., indications and warnings of intent). In current and future operational environments such as Global War on Terrorism (GWOT) and Maritime Domain Awareness (MDA), warfighters require technologies evolved to support information needs regardless of location and consistent with the user’s level of command or responsibility and operational situation. Net-centric operations include communications and information assurance capabilities to enable all-source data access, multi-source processing, and tailored dissemination to C2 and ISR users across the network. The operational benefits sought are an increased speed, accuracy and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority. Technologies emphasized provide warfighters with a robust, secure, mission responsive network; integrated information leading automated courses of action; and presentation of knowledge to speed understanding. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

This project explores and demonstrates technologies that enable options for FORCEnet, Sea Shield, and Sea Strike pillars. This project contains investments in the following FORCEnet, Sea Strike and Sea Shield enabling capabilities: Hostile Fire Detection and Response, Next Generation Command, Control and Decision Support, Combat ID Information Management of coordinated Electronic Surveillance, Combat ID in the Maritime

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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.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2005	FY 2006	FY 2007
NETWORK COMMAND, CONTROL AND COMBAT SYSTEMS	19,455	12,076	16,261

This initiative explores development of advanced technologies that contribute to integrated decision-making and mission execution to achieve battlespace superiority. In current and future operational environments, such as the Global War on Terrorism and Maritime Domain Awareness, warfighters require technologies evolved to support information needs regardless of location and consistent with the user’s level of command or operational situation. To achieve this, it must be possible to automate understanding of the battlespace by identifying objects, determining relationships among the objects, assessing intent, and automatically generating courses of action with associated risks and uncertainty. This initiative focuses on information integration, examining the critical S&T needs of automatic association and merger of information for unified presentation; automated recognition and cueing for significant patterns of information, computer-aided reasoning for task-oriented information dissemination; timely, accurate information and sensor fusion from heterogeneous sources, as well as supporting technologies to provide the understanding and relationship of different entities shown in the battlespace and their collective intent. This initiative will focus on advanced or novel approaches for processing and fusing information from disparate sources (e.g., images, intelligence sources); optimal decision aids incorporating rigorous decision theory and automated inference and reasoning; and assuring information integrity and availability according to mission objectives.

FY 2006 decreases because many projects will be transitioning to Systems Commands and other Sponsors as well as the realignment of Swampworks and Tech Solutions efforts and funding to PE 0603578N effective FY 2006. The increase in funds between FY 2006 and FY 2007 results from increased emphasis on information integration. FY 2005 through FY 2007 also reflects the realignment of efforts previously reported under the Computing and

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Advanced Sensing activity.

FY 2005 Accomplishments:

• Continued the development of algorithms and demonstration of data reduction through joint classification and feature optimization, realizing transfer of data to information, realizing A/I vis-a-vis Analog/Digital data (reduced bandwidth requirements and reduced burden on analysts and warfighters).
• Continued the development of a feature extraction module that segments the video based on video mosaicing.
• Continued the development of algorithms with Naval/Joint imagery systems to handle video metadata, which includes Global Positioning System, time, and sensor information.
• Continued the development of recommendations for standardizing the storage and linking of feature descriptions within a common database framework.
• Completed the evaluation of value of three dimensional techniques to enhance visualization technology.
• Completed the worst-case detection and conflict avoidance experimentation for the Real Time Deconfliction effort.
• Initiated the development and characterization of a new target detection and recognition algorithms to exploit higher dimensional data (spatial, temporal, and spectral) within the Network Centric Warfare framework. Approach utilizes advanced correlation approaches to provide improved target detection and recognition performance by integrating multiple sensor measurements.
• Initiated the development of a suitable ontology for exercising large-scale distributed situational threat awareness in Naval battlespace environments.
• Initiated the development of a Case-Based Reasoning simulation/model for implementing situation, threat awareness fusion solutions and a Bayesian Network inference engine for manipulating uncertainty and learning from data.
• Initiated the development of an initial prototype for an information sharing infrastructure that maintains data integrity and confidentiality for enclaves of networked workstations running Commercial Off the Shelf (COTS) operating systems and applications.
• Initiated the demonstration and conducted image registration error analysis for the multi-resolution and multi-scale image processing effort.
• Initiated the augmentation of the real world information with computer-generated information in the Battlefield Augmented Reality System effort. The activity designed a modular framework to support the system design and enables the insertion of custom scheduling and replication solutions. Other efforts focused on the middleware layer to support emerging network centric sensor-to shooter systems.
• Initiated development of automated methods for identifying significant changes between temporally separated

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images (not video) to extend work on automatic target recognition and pattern recognition into change detection algorithms.
• Initiated demonstration of a FORCEnet limited objective experiment the application of new techniques of discrete optimization, statistical discrimination, and artificial intelligence for the resource allocation of weapons. Compared initial results with high fidelity physics based models for threat and anti-threat weapon systems for continued development of Anti-Air Warfare optimization algorithms.

• Completed development of technology to improve fidelity in Marine Infantry combat simulators via virtual locomotion and collision detection. (NRL)
• Continued research and demonstrations of modulated near-infrared (IR) optical retroreflector data to develop spacecraft to spacecraft data exchange techniques. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)
• Continued development of "through-the-sensor" exploitation techniques to obtain environmental information from shipboard radars, and use of that information in nowcasting. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)
• Continued to evaluate improved method to automatically account for atmospheric effects on hyperspectral data and apply anomaly detectors, matched filters, and new algorithms for hyperspectral target detection. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)
• Continued development of technology for improving reliable system to survive Information Warfare attacks. (Previously reported under the Computing and Advanced Sensing activity.)
• Initiated development of technology for improved steganography and watermarking. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)
• Initiated development of technology for improving voice data interpretation and presentation to cope with audio information overload in Navy Systems. (NRL)
• Initiated development of technology to improve collaborative operational planning for tactical users using Head-Up Displays. (NRL)
• Initiated development of technology for improving face recognition technology via enhanced image registration software. (NRL)

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FY 2006 Plans:

• Continue all efforts from FY 2005, less those noted as completed above.
• Initiate development of sensor management algorithms that reduce the amount of labeled training data required, employing semi-supervised classifier and active learning techniques motivated by asymmetric threat, which limited training data anticipated.
• Initiate demonstration of predictive surface platform threat behavior algorithms and software employing techniques using pattern recognition on geospatial and attribute data. Also develop autonomous monitoring and reporting of high interest and anomalous maritime vessels.
• Initiate demonstration of a trusted data store which maintains data pedigree and detects anomalies in a limited objective experiment.
• Initiate efforts in ontology-based information fusion for enhanced situational awareness and classification-based knowledge discovery.
• Initiate efforts in Joint Director of Laboratory's Data Fusion Model Level 1/2/3 data fusion using abductive reasoning, Bayesian networks, agent-based techniques, statistical-based methods, and other approaches.
• Initiate efforts in automated image understanding that use active computations and visual pattern recognition for networked target recognition systems in maritime domain awareness.
• Initiate efforts in the automated integration disparate sources of information that involve data mining methods and game theory.

• Complete development of new algorithms for hyperspectral target detection in oblique geometries. (NRL)
• Initiate the implementation of a real-time anti-ship missile (ASM) state assessment capability against modern threats by embedding algorithms in a real-time processor. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)

FY 2007 Plans:

• Continue all efforts from FY 2006, less those noted as completed above.
• Initiate demonstration of anomaly detection, feature-based target tracking, track-to-pattern association and scoring, track-to-group clustering, pattern discovery and learning, pattern templates/descriptions and predictive modeling tools in a limited objective experiment.
• Initiate development of an interface between the Level 1 and Level 2/3 data fusion processes across federated service oriented architectures.
• Initiate development of new data schemas and methods to allow more efficient assembly of a Common

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Operational Picture (COP) integrating informational content from images, track data, intelligence and incomplete track data.
• Initiate development of semi-supervised detection algorithms for multi-sensor imagery, video and human intelligence that will enable self-deploying sensor networks.
• Initiate Level 1 fusion algorithm and architecture design with associated ontology to manage information from automated sensors to provide a more dynamic and accurate battlespace picture through improved object refinement.

• Complete development technology for improving face recognition technology via enhanced image registration software. (NRL)
• Complete the implementation of a real-time anti-ship missile state assessment capability against modern threats by conducting an empirical performance evaluation and analyze system implications. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)

	FY 2005	FY 2006	FY 2007
KNOWLEDGE SUPERIORITY AND ASSURANCE	16,690	4,575	6,993

KSA explores fundamental technologies that enhance the Navy’s capability to exploit, manage and integrate complex, heterogeneous, multi-source information for the next generation common picture. Science and Technology (S&T) work is being focused on Navy and Marine Corps Warfighter Capability Gaps identified through analysis of operational and exercise lessons learned, as well as campaign analysis of capabilities required in the 2010-2015 time frame.

Currently, small surface, ground and airborne platforms have little to no situation awareness or self-protection, which jeopardizes their effectiveness and survivability. The Electronic Warfare Integrated System for Small Platforms (EWISSP) program focuses on closing that gap by developing Electro-optic/Infrared (EO/IR) technologies to provide them with a full spectrum threat warning and countermeasures capability. This capability, when integrated with future emitter identification and Low Probability of Intercept radar detection systems, will provide netted targeting information and cueing that enables self-protection. (This effort moves to Sea Strike under PE 0602114N in FY 2007.)

There are several FNC efforts that completed in FY 2005 and three efforts transitioning to other PEs in FY 2006. The funding profile from FY 2006 to FY 2007 reflects the reorganization of Future Naval Capabilities (FNC) Program investments into Enabling Capabilities (ECs). As a result of this reorganization, the funding

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for each EC has been aligned to a Budget Activity 2 and Budget Activity 3 PE as appropriate. Warfighter Capability Gaps are being addressed by Enabling Capabilities (EC). Each EC delivers capability-level products to acquisition in a three to five-year effort, and allocates a sufficient investment to ensure a capability is provided. ECs addressed include: Next Generation Command, Control and Decision Support Services; Control and Decision Support Services; Combat ID Information Management of Coordinated Electronic Surveillance; Combat ID in the Maritime Domain to Reveal Contact Intent; Automated Control of Large Sensor Networks; as well as Hostile Fire Detection and Response Spiral 1 (in direct support of investments formerly reported under Sea Strike Platform Protection/Electronic Warfare Systems), which, to eliminate redundancy and more accurately describe underlying S&T investments, is included in this activity. This program activity also includes the Reconnaissance, Surveillance and Target Acquisition integrated forecasting and planning tools (previously in PE 0602131M) and the autonomous control of large sensor networks for intelligent autonomous Unmanned Aerial Vehicles (UAV) control program (previously in PE 0602114N).

FY 2005 Accomplishments:

• Continued Environmental Visualization forecasting algorithms to provide information less than an hour old for strike operations as well as Meteorology and Oceanography (METOC) forecasting tool for surface, subsurface, and Special Operations Forces.
• Continued the EWISSP effort by exploration and refinement of the subsystem interface software that will operate via Versa Module Eurocard (VME)-64 and Recommend Standard (RS)-422 buses.
• Completed development of Cryptologic Management and Analysis Support System (CMASS) software to provide a single repository for intercept data, automatic operator alerting, and voice analysis; conducted operational test and transitioned to Ship Signal Exploitation Space, SSES (Increment E) Program Management of Warfare Systems (PMW) 180. Follow-on effort called Processing Tactical Signal Intelligence will begin in FY 2006 under PE 0603235N.
• Completed exploration and refinement of the subsystem interface software for the EWISSP effort.
• Completed the Net Centric Enterprise Services (NCES) work to establish and demonstrate an Extensible Common Operational Picture (XCOP) with data management framework that enabled more rapid and timely technical and developmental exploitation of emerging, complex, and heterogeneous data sources for the Common Picture. Transitioned to Global Command and Control System - Maritime (GCCS-M)(PMW-150).
• Completed refining the Analytic Support Architecture (ASA) that improved location accuracy for air defense threats and transitioned to GCCS-M (PMW-150).
• Completed refining Automated Digital Networking System/Teleport/Global Information Grid-Bandwith Expansion (ADNS/Teleport/GIG-BE) to ensure High Assurance Internet Protocol Encryption (HAIPE) Interoperability and

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transitioned to PMW 790 shore integration, PMW 160 IA networks and enterprise services, ADNS Increment III, DISA GIG-BE, and Teleport Gen III.
• Completed refining Dynamic Bandwidth Resource Manager and transitioned to C4I & Space SPAWAR PMW-160.
• Completed Rapid Maritime Identification and Tracking System (RMITS) to provide bio-metric identification tools for special operation forces and Naval Boarding parties. Transitioned to Special Operations Mission Planning Office.
• Initiated effort called High Altitude Relay and Router Package to provide wide-band connectivity to tactical units in theater (moves to PE 0603271N in FY 2006).

FY 2006 Plans:

• Continue all efforts of FY 2005, less those noted as completed above.
• Complete Environmental Visualization.
• Initiate the exploration of rapid course of action development using synthetic semi-automated forces for fast, large-scale, and high-fidelity simulations; including models of human cognition and visualization techniques for assessing outcomes and uncertainties.
• Initiate test of the subsystem interface for the EWISSP effort. This effort moves to Sea Strike under PE 0603114N in FY 2007.

FY 2007 Plans:

• Continue all efforts of FY 2006, less those noted as completed above.
• Continue the EWISSP effort: moves to Strike and Littoral Combat Technologies under PE 0602114N in FY 2007.
• Continue effort for Improved Maritime Commercial Operational Tactical Picture in a GIG-ES Environment (previously reported in PE0603235N). This effort provides software to perform level one fusion of intelligence sources and tactical organic sensors to provide knowledge about battlespace objects including location, track, and Combat Identification.
• Continue developing and testing airborne and shipboard battle manager platforms for UAVs operating from Littoral Combat Ships. Continue developing and begin testing an open architecture airborne control station that can be used onboard a P-3 type aircraft for the control of multiple UAVs (Previously reported in PE 0602114N).
• Complete development of multi-vehicle cooperation technologies.

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• Complete medium-fidelity simulation of multi-vehicle cooperation technologies for multiple classes of Naval unmanned vehicles in littoral Intelligence Surveillance and Reconnaissance (ISR) (Previously reported in PE 0602114N).
• Initiate design of tools enabling mission-specific tactical sensor fields for at least two separate mission areas.
• Initiate design of tactical distributed data analysis and automated indications and warnings for 50% of tactical data.
• Initiate design of automated tactical platform and sensor planning and management sufficient for one operator to control of multiple sensors.
• Initiate development of object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment.
• Initiate Joint Director of Laboratories Data Fusion Model Level 2/3 data fusion research exploring techniques using Bayesian networks, Dempster–Schafer Evidential Reasoning and other techniques for analyzing operational data in establishing routine behaviors & dependencies based on multi-INT fusion and anomaly recognition that indicates hostile intent in the maritime/littoral domain.
• Initiate investigation of smart tactical sensors, platforms, and algorithms in an urban/cluttered environment for at least 2 sensing modalities.
• Initiate investigation of human to tactical sensor field interface to enable the user to locate relevant knowledge within 3 minutes.
• Initiate investigation of local tactical net and Distributed Common Ground Station information interfaces to achieve Level 1 integration.
• Initiate the all-source track and identity fusion effort integrating a broad range of intelligence product information including: Kinematic Radar Reports, Organic and UAV imagery, electronic and communications emissions and human spot reports for tactical and organic sensors to be augmented with national sensors.

	FY 2005	FY 2006	FY 2007
COMMUNICATION AND NETWORKS	11,315	10,990	11,955

This initiative develops wireless communications network technologies critical to the performance and robustness of naval communications for air, ship, submarine, and land platforms. Developments include bandwidth efficient communication techniques; advanced networking techniques for robust, highly dynamic environments; interoperable wireless networks for secure communications and protocols; bandwidth and network management techniques that can effectively manage and allocate bandwidth across tactical and theater levels in support of wireless network centric operations. The exploration payoffs include increased network data rates,

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improved coalition interoperability, dynamic bandwidth management, greater mobile network connectivity, and efficient waveforms to improve communications with land forces.

FY 2005 and out reflects the realignment of efforts previously reported under the Computing and Advanced Sensing activity. The increase from FY 2006 to FY 2007 is due to increased emphasis in wireless communications.

FY 2005 Accomplishments:

• Continued the development of a high efficiency communications transmitter. Enhanced efficiency with commercial filters and switches will be demonstrated.
• Continued development of nonlinear adaptive equalizer for Ultra-High Frequency (UHF) submarine communications. Began tests to provide a proof of concept that will be tested at sea.
• Continued the development of a Very High Frequency (VHF)/UHF Power Amplifier (PA). Demonstrated that a significant reduction in size, weight, and waste power can be achieved.
• Continued development of the 802.11s standard that will specify a complete Enhanced Service Set Mesh architecture, including auto configuration, dynamic broadcast/multicast/unicast routing, end user mobility, security, and integration with other 802 Local Area Network.
• Completed the Joint Tactical Radio System (JTRS) Maritime Spectrum Awareness and Spectrum Adaptive Polyphase Waveform by finalizing development of Digital Signal Processing algorithms and transitioning these algorithms to programmable JTRS platforms.
• Completed the study of Next Generation Tactical Internet Protocol (IP) networks. Prototyped and tested a number of protocols within the established test beds, updated transition papers, and continued Internet standards development and commercial interaction.
• Completed the peak-to-average ratio improvements for orthogonal frequency division multiplexed (OFDM) signaling with constant envelope.
• Completed work on Interoperable Networks for Secure Communications (INSC) Phase II that will permit transition of INSC technologies into Navy Automated Digital Networking System (ADNS) by FY 2006. Completed initial research and demonstrated a number of IPv6 and IPv4 mobile networking technologies within the coalition architecture.
• Initiated project to mature the superconducting cross-correlator to technology readiness level 6 to enable the development of a multi-function multi-net digital-Radio Frequency dehopping receiver for Link-16. This involves the integration of High Temperature Superconductors analog and Low Temperature Superconductors digital circuits in a COTS two-stage cryocooler.

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• Initiated optical receiver design using avalanche photo-diodes and array-detection techniques for laser communications over the sea in poor weather.
• Initiated research and development into multiple-in-multiple-out (MIMO) antenna technology and OFDM signaling to improve data throughput (500 Mbps) in strong multipath environment.

• Completed demonstration of robotic space rendezvous using real time range imaging and target tracking in the Naval Research Laboratory's Space Robotics Laboratory. (NRL)
• Completed research to improve tactical networks via the development of models, analysis methodologies, and simulation tools. (NRL)
• Completed development of signal processing techniques for digital Electronic Support Measures receivers to detect and identify advanced radar and communication modulations in the presence of non-Gaussian interference sources. (NRL) (Previously reported under Computing and Advanced Sensing activity.)
• Continued development of technology to improve mobile, ad hoc networks (MANET) via multi-agent programs. (NRL)
• Continued research and demonstrations of modulated near-infrared (IR) optical retroreflector data to develop spacecraft to spacecraft data exchange techniques. (NRL) (Previously reported under Computing and Advanced Sensing activity.)
• Continued development of Specific Emitter Identification (SEI) algorithms for communications signals by conducting lab tests and investigating combinations of precision classical parametric measurements and SEI techniques. (NRL) (Previously reported under Computing and Advanced Sensing activity.)
• Continued construction and characterization of spectrally clean, out-phased high-power transmitter using X-band monolithic microwave integrated circuit (MMIC) technology, developing Continuous Wave (CW) radar receiver technology implementing wideband 500-MHz linear chirp at the X-band transmitter, and Ballistic Missile Defense (BMD) discrimination by performing experiments to study micro-Doppler signatures from BMD targets that undergo micro-motions. (NRL) (Previously reported under Computing and Advanced Sensing activity.)
• Initiated the design, fabrication and testing of adaptive radio frequency (RF) elements for autonomous systems to increase the RF performance of small stationary autonomous systems. (NRL) (Previously reported under Computing and Advanced Sensing activity.)
• Initiated development of a concept for recovering Global Positioning Systems (GPS) signals in a "friendly" jamming environment thus allowing GPS to be used while denying that capability to an adversary. (NRL)
• Initiated development of technologies in support of responsive micro-satellites including high speed W-band communications, compact deployable structures, and small, xenon electric propulsion systems. (NRL)

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FY 2006 Plans:

• Continue all efforts of FY 2005, less those noted as completed above.
• Complete and provide a proof of concept, tested at sea, for the nonlinear adaptive equalizer for UHF submarine communications, mitigating multi-path and narrow band interference. Transition to fleet by Digital Signaling Process software upgrades in submarine UHF receivers.
• Complete the development of an efficient VHF/UHF power amplifier using non-linear components. Transition this effort to the JTRS program.
• Complete the development of a high efficiency communications transmitter based on delta-sigma modulation. Investigate transition path to deployment, including manufacture.
• Complete the development of the 802.11s standard.
• Complete the prototype lab models for MIMO and OFDM signaling.

• Complete efforts on independent high-power radar operation, CW radar receiver technology, and BMD discrimination. (NRL)
• Initiate development of technology to improve tactical network Satellite Communication linkage and multi-user detection. (NRL)
• Initiate development of an adaptive rate terminal to maintain laser communications in poor weather conditions.
• Initiate the development of free space hybrid Infrared laser communications links with greater than 10X bandwidth of digital link for same power. (NRL)

FY 2007 Plans:

• Continue all efforts of FY 2006, less those noted as completed above.
• Complete the cryogenic packaging, test and demonstrate direct digital dehopping of multiple Link-16 waveforms. Establish transition path to JTRS-compliant communications.
• Complete the development of an adaptive rate terminal to maintain laser communications in poor weather conditions. Test the system at NRL’s 32 km maritime Chesapeake Bay test bed. Establish transition path to fleet deployment.
• Complete research and development in MIMO antenna technology and OFDM signaling to improve data throughput (500 Mbps) in strong multipath environments. Finish prototyping of lab models. Finish demo in urban environment. Explore possible transition to United States Marine Corps and/or JTRS.
• Initiate development of high data rate communications (> 1 Gbps data links) for small UAVs, meeting the

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size, weight and power requirements.
• Initiate development of Robust Airborne Networking Extensions (RANGE) for joint battlespace networking, networking Unmanned Aerial Vehicles (UAV), and hybrid mobile ad hoc networking (MANET)/satellite operation. Implement MANET and MTR protocols for cross-layer optimization, including disruption tolerant networking to sensors and platforms.
• Initiate development of an ultra-wide band (UWB) groundwave communication for a distributed sensor network (buoy).

• Complete development of technology to improve mobile, ad hoc networks via multi-agent programs. (NRL)
• Complete communications SEI by transitioning best approaches into operational Navy electronic support and electronic attack systems. (NRL)
• Complete the design, fabrication and testing of the phased array RF elements for autonomous systems with the fabrication of a prototype unmanned system. (NRL)
• Initiate development of technologies in support of responsive micro-satellites including laboratory demonstrations of optimized xenon electric propulsion system and deployable structures. (NRL)
• Initiate development of a broadband electronically-steerable array for mission security (BEAMS) based on Rotman microwave lens beam forming/steering techniques and apply to small UAV directional communications.
• Initiate expanded study of “friendly” GPS jamming techniques to include those designed specifically to minimize fratricide while maintaining effectiveness of jamming against threat GPS receivers (NRL)
• Initiate development of advanced free space communications to include performance tests in marine environments. (NRL)

	FY 2005	FY 2006	FY 2007
MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION	6,775	8,690	12,090

This activity addresses theater air and missile defense (TAMD) needs for rapid, high confidence Combat Identification (CID) of air and missile threats at long range using real time and non-real time threat attributes and intelligence information. This activity supports the Sea Shield Pillar Enabling Capability of Real Time Long Range Air Defense CID in Support of Early Engagements and related CID Science & Technology to be worked under the FORCEnet FNC.

The Multi-Source Integration effort, Composite Combat Identification, and Advance Sensor Netting Technology efforts complete in FY 2007. The funding increase from FY 2006 to FY 2007 is to complete the technology/algorithm development of these efforts.

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FY 2005 Accomplishments:

• Continued laboratory demonstrations of ASNT and CCID.
• Continued MSI project development and testing of algorithms to integrate real time and non-real time sensor data and correlate satellite communications (SATCOM) data in the E-2C aircraft mission computer.
• Continued development of ASNT algorithms for integration of electronic warfare support (ES) data into the Open Architecture Track Manager in future combat systems and transmission of track ID attributes via real time sensor networks.
• Continued development of CCID algorithms to correlate and fuse real time tracks with intelligence, surveillance, and reconnaissance data in Ship Signal Exploitation Equipment (SSEE) equipped surface ships and common reasoning algorithms for CID capability to rapidly build high confidence identification of air tracks using all available ID attributes in theater.

FY 2006 Plans:

• Continue all efforts of FY 2005.

FY 2007 Plans:

• Complete ASNT, CCID, and MSI development. MSI, ASNT, and CCID will transition to the E-2C/D Program Management Office (PMA-231), Intelligence, Surveillance, Reconnaissance, and Information Operations Program Office (PMW-180), and Program Executive Office-Integrated Warfare Systems (PEO-IWS).

	FY 2005	FY 2006	FY 2007
HUMAN FACTORS AND ORGANIZATIONAL DESIGN	4,500	5,410	6,178

This activity (formerly Human Computer Interface) focuses on improving platform, task force, and battle group operations by developing decision support technology for incorporation into operational systems. The goals are to enhance human performance effectiveness; improve decision support and decision-making collaboration; improve human-centered design; and accelerate insertion of advanced human factors engineering technology into existing and new weapons systems. The payoff is the creation of decision-action cycles that are faster than an enemy’s, and reduced workload and staffing requirements. Specific objectives include achieving improved situational awareness and speed of command through a deeper understanding of human capabilities and

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limitations; as well as accomplishing quality performance in complex, dynamic, high-tempo, and uncertain threat environments. These objectives are being pursued in three focus areas: Decision Support and Organizational Design, Collaboration and Knowledge Management, and Human-Computer Interaction/Visualization.

The funding profile increases from FY 2005 due to additional emphasis and expansion of the exploration of cognitive modeling and exploration of Human-Computer Interfaces to large complex data sets including the GWOT.

FY 2005 Accomplishments:

• Initiated evaluation of Latent Semantic Analysis of operator communications as an effective metric of shared situational awareness in unmanned aerial vehicle control teams.
• Initiated demonstration of Electronic Card Wall (EWALL) (a computational human cognitive processing system) for representation and transfer of meaning among heterogeneous and distributed team members engaged in complex problem solving.
• Initiated developing jointly with the Naval Air Systems Command, a FORCEnet-based test bed to identify and evaluate the cognitive processes to be employed to optimize collaborative decision-making in a geographically distributed and time-delayed situation.
• Initiated model-based simulations and experiments to investigate the effectiveness of heterarchical organizational structures in network-centric operational environments in order to evaluate the implementation of FORCEnet concepts.
• Initiated development of new threat scenarios incorporating Joint Force Maritime Component Commander operations, counter-insurgency and humanitarian operations with the staff of the Naval War College. These new threat scenarios will provide the basis for Limited Objective Experiments in the Innovation Laboratory at the Naval War College.
• Initiated development of Dynamic Network analysis (a terrorist network analysis tool) in operational command setting at U.S. Pacific Command.
• Initiated the improvement of terror network analysis decision tools for combatant command use and military planning, including testing of tools, development of metrics, and validation.
• Initiated development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays.
• Initiated evaluation of the effectiveness of a change history tool to minimize the effect of interruptions.
• Initiated application of cognitive architecture modeling to the design of interface analysis tools.
• Initiated deployment of models for Effects-Based Operations (EBO) aboard naval vessels to support Expeditionary Group One to conduct kinetic and non-kinetic tactical operations in a measured manner.

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• Initiated development of a cognitive model of human performance with 3D audio displays.
• Initiated development of technology to improve voice biometrics via the development of multi-dimensional, adaptive speaker verification technology. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)

FY 2006 Plans:

• Continue all efforts of FY 2005.
• Initiate jointly with the Air Force applied research on the integration of Information Operations in Air Control Centers.
• Initiate applied research on command and control adaptive architectures for Expeditionary Strike Groups working with OPNAV N-75B and Expeditionary Strike Group ONE, San Diego.

FY 2007 Plans:

• Continue all efforts of FY 2006.
• Initiate the development of advanced computational models capable of analyzing multi-dimensional networks of thousands of nodes. Current capabilities enable the analysis of networks consisting of hundred of nodes.
• Initiate the development of computational models of influence that incorporate the social structure, values and cultural processes of urban non-western communities for achieving post-conflict stabilization.
• Improve response speed of the LSA tool to a near-interactive level and incorporate into a fleet experiment. Collect and evaluate data to validate improved speed and effectiveness of developing situational awareness.
• Incorporate the EWALL prototype into the Tactical Operations Center of the Special Operations Forces and collect performance data to validate effectiveness.
• Initiate Sea Basing research on rehearsal for Expeditionary Strike Groups in the conduct of maritime interdiction missions and developing reach-back capability for computationally intense analysis for evaluating courses of action.

• Complete development of technology to improve voice biometrics via the development of multi-dimensional, adaptive speaker verification technology. (NRL) (Previously reported under the Computing and Advanced Sensing activity.)

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	FY 2005	FY 2006	FY 2007
TACTICAL SPACE EXPLOITATION	0	15,000	14,875

The Tactical Space Exploitation initiative explores the application of new technologies on small, light-weight and low-cost satellites to enhance naval warfighting capabilities; taking advantage of the global access, revisit and connectivity provided by orbital platforms. Initial efforts will be aimed at developing integrated signals electronics packages to test new concepts for global ship tracking and two-way data exfiltration using next-generation Internet Protocol (IP) technology from an array of sea-based and land-based sensors. Advanced multispectral/hyperspectral electro-optical sensors will be developed to demonstrate new warfighting constructs.

This effort begins in FY 2006.

FY 2006 Plans:

• Initiate development of integration plans, algorithms, and satellite concept of operations to demonstrate the integrated signals payload as a secondary payload on an FY 2007 small satellite launch.
• Initiate development of small multifunctional integrated signals electronics systems for ship tracking from space and two-way data exfiltration from distributed global sensors.
• Initiate development of a satellite-borne electro-optical sensor system for FY 2008 launch on a small satellite to test new techniques for surveillance of environments and targets of naval interest for anti-submarine warfare and mine warfare.
• Initiate and complete system designs including configuration of satellite hardware electronics to enable procurement of flight parts.
• Initiate preliminary environmental and flight testing of hardware components.

FY 2007 Plans:

• Continue all efforts of FY 2006.
• Complete preliminary environmental and flight testing of hardware components.

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CONGRESSIONAL PLUS-UPS:

	FY 2005	FY 2006
AIREP (FORMERLY UESA)	11,186	5,550

FY 2005: This effort developed the track adaptive processor, an Identification Friend or Foe (IFF) capability for circular arrays and a data collection capability and modifyed the radar for wideband capability.

FY 2006: This effort supports Advanced Integrated Radar Electronics and Photonics (AIREP) research.

	FY 2005	FY 2006
COMMON SENSOR MODULE (COSM)	1,737	0

Conducted field demonstrations with existing electro-magnetic sensor and upgraded classification algorithm based on neural nets to identify vehicles based on electro-magnetic emissions. Expanded library of signatures to include almost two-dozen commercial and military vehicles.

	FY 2005	FY 2006
COORDINATED OPERATION OF UNMANNED VEHICLE FOR LITTORAL WATERS	0	2,600

This effort supports coordinated operation of unmanned vehicle for littoral waters research.

	FY 2005	FY 2006
CRITICAL AREA PROTECTION SYSTEMS HIGH RESOLUTION SITUATIONAL AWARENESS	0	1,500

This effort supports critical area protection systems high resolution situational awareness research.

	FY 2005	FY 2006
EXPEDITIONARY WARFARE TESTBED GLOBAL INFORMATION GRID ENTERPRISE SERVICES	0	1,000

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This effort supports expeditionary warfare testbed global information grid enterprise services research.

	FY 2005	FY 2006
M2C2	5,787	6,500

FY 2005: This effort developed an early entry command, control, and communications payload, with associated technologies, suitable for future insertion into the Marine Corps to-be-selected internally transportable (in the MV-22) vehicle. It provided on-the-move, over-the-horizon connectivity with limited terrestrial communications and command and control capabilities for the local on-site commander.

FY 2006: This effort supports Mobile Modular Command and Control(M2C2) research.

	FY 2005	FY 2006
NAIF	5,787	5,100

FY 2005: The Network Applications Integration Facility (NAIF) served as an exercise center for the Third and Seventh Fleet demonstrations and for the development of Tactical Component Network interfaces with systems such as the Advanced Digital Network System. NAIF developed Hawaiian tech base development through participation of Hawaiian technology firms in Navy's program interface development for use in the Tactical Component Network.

FY 2006: This effort supports Network Applications Integration Facility (NSIF) research.

	FY 2005	FY 2006
NATIONAL CENTER FOR ADVANCED SECURE SYSTEMS RESEARCH (NCASSR)	4,822	0

Funding addressed continuing advancements in comprehensive vulnerability analysis and the development of tamper-resistant hardware and software.

	FY 2005	FY 2006
PACIFIC THEATER DATA FUSION TESTBED	0	1,700

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This effort supports pacific theater data fusion testbed research.

	FY 2005	FY 2006
RADIO SENSOR MODULE (RASM)	0	1,200

This effort supports radio sensor module research.

	FY 2005	FY 2006
SEADEEP	2,412	0

Funds supported technologies to demonstrate a two-way sensor data link for high data rate, low probability of intercept, communications between airborne platforms and submerged submarines. Demonstrated the use of a steerable Micro-electro Machine System to steer a laser beam in a small unmanned vehicle.

	FY 2005	FY 2006
SENSORNET	0	17,500

This effort supports sensornet research.

	FY 2005	FY 2006
TESTING, EVALUATION AND DEMONSTRATION OF WEBSTER	1,446	0

Webster, web-based information fusion system for counter-terrorism operations (CTO), explicitly accounted for uncertainty in data. It used data from multiple existing INTEL and open source systems (especially the World Wide Web (WWW)) to produce a high-level information system that specifically quantifies data certainty and source reliability. Webster modeled each step of the normal intelligence analytical process (collect, fuse, analyze, report, and disseminate) and attempts to estimate uncertainty that arises along the way. Accelerated development and testing of Webster to support operational needs.

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	FY 2005	FY 2006
THEATER UNDERSEA WARFARE INITIATIVE	7,330	6,000

FY 2005: This effort developed Theater Under Sea Warfare (TUSW) Program tools with the addition of operations rehearsal simulations, enhancements to the Asset Allocation Tool (AAT), evaluation of TUSW tools in Undersea Warfare exercises and the study of composable FORCENet integration, automated extraction of asset status and Commercial Joint Mapping Took Kit (CJMTK) cartography benefits.

FY 2006: This effort supports theater undersea warfare research.

	FY 2005	FY 2006
WEB-BASED TECHNOLOGY INSERTION	963	0

This effort took emerging web based solutions and applied them to an area such as time critical targeting and expeditionary warfare applications, and determined the effectiveness of using enterprise solutions to provide a universal operator interface and to allow interoperability with existing systems. Upgraded capabilities to automate discovery and access functions to lower operator workload. Tested to determine suitability of new tools.

	FY 2005	FY 2006
WEBSTER INTEGRATION	0	1,000

This effort supports webster integration research.

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C. OTHER PROGRAM FUNDING SUMMARY:
NAVY RELATED RDT&E:

PE 0601153N (Defense Research Sciences)
PE 0602114N (Power Projection Applied Research)
PE 0602123N (Force Protection Applied Research)
PE 0602131M (Marine Corps Landing Force Technology)
PE 0602236N (Warfighter Sustainment Applied Research)
PE 0602271N (RF Systems Applied Research)
PE 0603114N (Power Projection Advanced Technology)
PE 0603123N (Force Protection Advanced Technology)
PE 0603235N (Common Picture Advanced Technology)
PE 0603236N (Warfighter Sustainment Advanced Technology)
PE 0603271N (RF Systems Advanced Technology)
PE 0603609N (Conventional Munitions)
PE 0603658N (Cooperative Engagement)
PE 0603640M (USMC Advanced Technology Demonstration (ATD))
PE 0603727N (Navy Technical Information Presentation System)
PE 0604307N (Surface Combatant Combat System Engineering)
PE 0604518N (Combat Information Center Conversion)
PE 0204152N (E-2 Squadrons)
PE 0205601N (HARM Improvement)
PE 0206313M (Marine Corps Communications Systems)

NON-NAVY RELATED RDT&E:

PE 0602204F (Aerospace Sensors)
PE 0602702F (Command Control and Communications)
PE 0602782A (Command, Control, Communications Technology)

D. ACQUISITION STRATEGY:
Not applicable.