FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: Common Picture Applied Research

COST: (Dollars in Thousands)

| PROJECT NUMBER/ TITLE | FY 2002 ACTUAL | FY 2003 ESTIMATE | FY 2004 ESTIMATE | FY 2005 ESTIMATE | FY 2006 ESTIMATE | FY 2007 ESTIMATE | FY 2008 ESTIMATE | FY 2009 ESTIMATE |
|---|---|---|---|---|---|---|---|---|
| Common Picture Applied Research | 122,933 | 148,222 | 59,022 | 70,120 | 82,545 | 87,503 | 77,142 | 78,598 |

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Common Picture Applied Research Technology Program addresses technology deficiencies associated with the Navy's Twenty-First Century Network Centric Warfare need for information as a resource and weapon. The focus is on a high performance network that achieves a common situational awareness to interconnect geographically distributed forces (surface, subsurface, air platforms and forward deployed forces) into a unified Naval Force. The program emphasizes the development of technology supporting real time planning and execution of Naval warfare missions ranging from land attack e.g., expeditionary and littoral warfare) to joint theater operations. Technology developments involve identifying and exploring technologies for the Fleet that: 1) provide desktop to desktop information services ashore and afloat; 2) support dynamic bandwidth and network management; 3) locate, extract and integrate critical, time sensitive information; 4) distribute information tailored to user needs; 5)provide a common, consistent understanding of the battlespace; 6) support interoperable secure networking among Naval, Joint, and Coalition forces. The goal is to provide decision-makers and warfighters with a robust, secure, mission responsive network; integrated information leading to 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 program's technology developments directly support Future Naval Capabilities (FNCs) in Knowledge Superiority and Assurance (KSA), Missile Defense (MD), Littoral Anti-Submarine Warfare (LASW) and Fleet and Force Protection (FFP). Within the Naval Transformation Roadmap, this investment will technically enable the “Persistent Intelligence, Surveillance, and Reconnaissance,” “Time Sensitive Strike,” “Sea Based Information Operations,” and “Ship-to-Objective Maneuver” capabilities required by “Sea Strike;” and "Theater Air and Missile Defense" capability required by "Sea Shield".

Due to the number of efforts in this Program Element (PE), the initiatives described are representative of the work included in this PE.

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B. PROGRAM CHANGE SUMMARY:

| | FY 2002 | FY 2003 | FY 2004 | FY 2005 |
|---|---|---|---|---|
| FY 2003 President's Budget Submission: | 124,370 | 75,594 | 74,106 | 69,800 |
| Adjustments from FY 2003 President’s Budget: | | | | |
| Congressional Plus-Ups | | 76,000 | | |
| SBIR Reduction | -1,022 | | | |
| Execution Adjustments | 249 | | | |
| Congressional Rescissions/Undistributed Reductions | -664 | -1,764 | | |
| S&T Program Adjustments | | | -12,762 | 2,726 |
| NWCF Rate Adjustments | | | -281 | -11 |
| Efficiencies at NWCF Activities | | | -400 | -382 |
| Pay Raise/Inflation Adjustments | | -1,608 | -1,641 | -2,013 |
| FY 2004/2005 President's Budget Submission: | 122,933 | 148,222 | 59,022 | 70,120 |

PROGRAM CHANGE SUMMARY EXPLANATION:

Schedule: Not applicable
Technical: Not applicable

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COST: (Dollars in Thousands)

| PROJECT NUMBER/ TITLE | FY 2002 ACTUAL | FY2003 ESTIMATE | FY 2004 ESTIMATE | FY 2005 ESTIMATE | FY 2006 ESTIMATE | FY 2007 ESTIMATE | FY 2008 ESTIMATE | FY 2009 ESTIMATE |
|---|---|---|---|---|---|---|---|---|
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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Knowledge Superiority and Assurance | 26,000 | 25,899 | 18,529 | 17,226 |

KNOWLEDGE SUPERIORITY AND ASSURANCE: This activity explores the underpinning technologies that enable network-centric operations, including the FORCEnet concept for Naval warfare. The approach involves technology exploration and development focus areas: 1) Common Consistent Knowledge; 2) Dynamically Managed, Interoperable, High-Capacity Connectivity; and 3) Time-Sensitive Decision Making. Common Consistent Knowledge addresses the needs of operating

forces for common picture information in the planning, monitoring, and re-planning cycle of operational and tactical force employment. This effort will further enhance the Navy's capability to exploit, manage and integrate complex, heterogeneous, multi-source information for the next generation common picture. Dynamically Managed, Interoperable, High-Capacity Connectivity addresses wireless network technology critical to the performance and robustness of Naval communications for air, ship, submarine and land platforms. This will enhance Naval communications with higher data rates, expanded coverage to disadvantaged platforms, and improved bandwidth management. Time-Sensitive Decision Making supports tactical operations where the timeliness and accuracy of decisions is crucial to the successful and efficient application of available forces. This effort will enable knowledge-based threat assessment and rapid response for emergent, time-critical events.

FY 2002 Accomplishments:
The Intelligent Marine Multi-Agent Command and Control System demonstrated improved interoperability and enhanced situational awareness to the individual warfighter through object-oriented and agent-based information architecture. The Real-Time Execution Decision System explored automated methods for monitoring, assessing, and evaluating threats to enhance a Carrier Battle Group staff's capability to respond in real-time to a dynamically changing battlespace environment, enabling airborne assets to attack time-sensitive targets. The Multi-National Virtual Operation Network demonstrated tactical and operational improvements in the timely exchange of information between United States and Allied/Coalition forces through the use of virtual private networks and secure web servers. The Cryptologic Management and Analysis Support System (CMASS) continued development of automated Indications and Warnings (I&W) tactical decision aids permitting an analyst to process large amounts of data in a short period of time. This initiative directly supports on-board platform data processing. The Environmental Visualization effort provided improved forecasting algorithms for existing Navy meteorological systems supporting strike operations in near real time.

This activity also pursued: (1) Knowledge Web Technologies to improve commanders' situational awareness by organizing and displaying web-based information from multiple warfare domain data sources; (2) Human Alerting and Interruption Logistics to improve watchstanders' performance and decision making through techniques that optimize performance when confronted with large amounts of data (attention management); (3) Efforts to develop middleware for the Defense Information Infrastructure (DII) and Common Operating Environment (COE) command and control systems with other naval systems that will improve interoperability between submarine tactical sensors; and (4) The Extensible Tactical Command, Control, Communications, Computers and Intelligence (C4I) Framework (XCTF) to increase speed of command through integration of multiple data sources.

FY 2003 Plans:
Continue CMASS algorithm development for I&W, including automatic recognition of reportable events and automatic generation of routine periodic reports. Continue refinement of the Environmental Visualization forecasting algorithms. Refine the Knowledge Web Technologies by expanding the integration of information from multiple sources. Refine the middleware for the DIICOE to improve interoperability in theater by enabling users to share contact information, overlays, fleet message information and displays. Continue Human Alerting and Interruption

Logistics through additional algorithms to assist in data management. XCTF will refine its efforts to develop an extensible data management framework to enable stove piped real-time and near real-time intelligence, surveillance, and reconnaissance (ISR) systems to share data and common services seamlessly, thus increasing the speed of command and span of information access. Other efforts will continue improving mission planning cycles by developing algorithms and tools that guide staffs through doctrine-based planning and continued development of architecture to improve mission planning by enabling automatic, rapid, and accurate assessments of air activities in preparing strike assets for attack. This activity will initiate the Underwater Surveillance Data-Link Network to develop a reliable, wireless over-the-horizon and line-of-sight bi-directional communication capability between remotely deployed sonobuoys and ships, aircraft and shore data processing stations and the Analytic Support Architecture to reduce the time required to manually discern enemy air defense activities.

FY 2004 Plans:
Continue development of CMASS software to provide one place in which to store intercept data, automatic operator alerting, and voice analysis. An operational test for CMASS is planned. Continue Environmental Visualization forecasting algorithms by providing information less than an hour old for strike operations. Conduct at sea tests in XCTF to establish and demonstrate a data management framework that enables more rapid and timely technical and developmental exploitation of emerging, complex, and heterogeneous data sources for the Common Picture. Knowledge Web Technologies will continue refinement and conduct demonstrations of the tools and procedures. The Analytic Support Architecture will be continued and refined to improve location accuracy for air defense threats. The Underwater Surveillance Data-Link Network will refine its algorithms and conduct a demonstration of its capabilities.

FY 2005 Plans:
Continue demonstrations of CMASS. Extend Environmental Visualization capabilities to large deck amphibious assault ships to support meteorological products for multiple users in support of strike operations. Continue Knowledge Web Technologies to provide integration operational and tactical source information for the common picture through information aggregation techniques, filtering, and data mining, as well as intelligent software agents. Refine the techniques for data management in XCTF to fuse heterogeneous data from multiple sources.

Other efforts will focus on integration and information sharing across component commands, tactical units, coalition forces, and non-governmental agencies by means of web-based crisis information management techniques, visualization capabilities, and group planning tools. In addition, this activity will explore rapid course of action development by means of synthetic semi-automated forces for fast, large-scale, high-fidelity simulations, including models of human cognition and visualization techniques for assessment of outcomes and uncertainties.

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Platform Awareness and Protection Electronic | 1,600 | 2,000 | 2,000 | 2,000 |

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PLATFORM AWARENESS AND PROTECTION/ ELECTRONIC WARFARE (EW) SYSTEMS: This activity supports the Fleet and Force Protection (FFP) Future Naval Capability (FNC). Current small platforms (both surface and airborne) have little to no situation awareness (SA) or self-protection against threat missile systems. This activity focuses on closing that gap by developing technologies that can provide these platforms the capability to achieve very accurate hemispheric direction finding (DF) of radio frequency (RF) signals to deny the enemy their effective use, or to exploit their weaknesses. This capability, when integrated with emitter identification and Low Probability of Intercept (LPI) radar detection systems, provides netted targeting information and cueing that allows for platform self-protection against various threat systems.

FY 2002 Accomplishments:
The Personal Communications Systems (PCS) Exploitation effort performed laboratory tests and continued integration and testing of optimized jamming techniques into the EA-6B aircraft. The Tactical Reactive Command and Control Warfare ($C^2W$)/Electronic Attack (EA) Network effort developed decentralized jammer resource management software that supports a heterogeneous mix of EA platforms. The Battlefield Ordnance Network Centric Employment (BONCE) effort developed a motion compensation algorithm. The Adaptive Mixed-Mode Very Large Scale Integration (VLSI) Sensors for Micro Air Vehicles (MAV) effort included scheduling of the final demonstration of sensors. Under the Electronic Warfare Integrated Systems for Small Platforms (EWISSP) effort the platforms' Concept of Employment (COE) was reviewed and trade-offs conducted, which led to the definition of performance requirements for an affordable EW System capable of providing substantially increased platform survivability.

FY 2003 Plans:
Evaluate data compression and transmission schemes and complete development of the detection algorithm framework and real-time processor under the BONCE effort. Analyze and optimize hardware for the proof-of-concept demonstration and identify concept performance and enabling technology factors under the Tactical Reactive C2W/EA Network effort. The EWISSP effort will perform Shipboard Laser Acquisition System (SBLAS) 90-degree system design studies and explore concepts for an optical slip ring for a two-piece flexible countermeasure mast.

FY 2004 Plans:
The BONCE effort will conduct laboratory performance explorations of a lightweight electro-optic/infrared (EO/IR) subsystem in preparation for Unmanned Aerial Vehicle (UAV) employment. The EWISSP effort will explore and develop subsystem for the 90-degree SBLAS system and a countermeasure system.

FY 2005 Plans:
Continue exploration and refinement of the subsystem interface software for the EWISSP effort.

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Multi-Source Integration and Combat Identification | 8,200 | 7,900 | 6,986 | 7,175 |

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MULTI-SOURCE INTEGRATION (MSI) AND COMBAT IDENTIFICATION (CID): This activity supports the Missile Defense Future Naval Capabilities (FNC). Efforts focus on development of technology that addresses needs for MSI, fusion, system architecture, automated sensor management and algorithms to fuse, filter and correlate on-board sensor and off-board battlespace information from tactical data links, satellite communications and interoperable cooperative engagement networks. Projects under this activity are the Affordable Ground Based Radar; Multi-Source Integration effort that reduces decision and response time, improves battlespace awareness and increases combat system efficiency and responsiveness; the Advanced Sensor Networking Technology (ASNT) that supports cooperative engagement capabilities; and the Composite Combat Identification (CCID) effort for missile defense that will build combat identification (CID) on air contacts using track attributes from real- and non-real time data.

FY 2002 Accomplishments:
This activity continued development of risk reduction technology for the Affordable Ground Based Radar (AGBR). This multi-mode, multi-functional radar is being developed on an accelerated schedule for USMC, which needs an advanced multi-functional mobile radar capability for Expeditionary Littoral operations. (This effort moved to PE 0603271N in FY 2003.) MSI efforts continued to improve E-2C aircraft situational awareness and reduce risk. To further develop the E-2C MSI technology, the activity investigated satellite communication (SATCOM) Electronic Surveillance Measures (ESM) correlation algorithms. The Advanced Sensor Networking Technology (ASNT) was initiated to enable Cooperative Engagement Capability (CEC) to integrate Electronic Surveillance (ES) sensors. The Composite Combat Identification effort developed algorithms for correlation of real-time track files from CEC with signals intelligence data in the EP-3E reconnaissance aircraft and Ship Signal Exploitation Equipment (SSEE) in surface ships. It also began development of a common reasoning algorithm for high confidence CID to be demonstrated in the naval open architecture combat system.

FY 2003 Plans:
The MSI activity will continue developing algorithms to integrate radio frequency (RF) Sensors, Identification Friend or Foe (IFF), and Joint Tactical Information Distribution System (JTIDS) to SATCOM data. In the ASNT project, the goals are to design and develop algorithms for ES data association and CEC track correlation. The CCID project will continue development of algorithms to correlate and fuse CEC data with ISR data processed aboard EP-3E aircraft and SSEE-equipped surface ships, as well as develop an advanced CID common reasoning algorithm for the naval open architecture combat system.

FY 2004 Plans:
The MSI activity will continue developing and testing algorithms to integrate RF Sensors, IFF, and JTIDS to SATCOM Electronic Intelligence data broadcasts. The ASNT project will continue development advanced algorithms for integration of ES data into the CEC program. The CCID activity will complete development of algorithms to correlate and fuse CEC data with ISR data processed onboard EP-3E aircraft and continue these effort for SSEE-equipped surface ships. It will also continue development of an advanced common reasoning algorithm for the naval open architecture combat system.

FY 2005 Plans:
The MSI activity will continue algorithm development efforts that integration of RF Sensors, IFF, CEC and JTIDS to SATCOM Electronic Intelligence data broadcasts in the E-2C aircraft and begin efforts to apply these algorithms to other platforms, including the naval open architecture combat system. The ASNT project will continue development of advanced algorithms for integration of ES data into the CEC program. For CCID, the effort will conduct subsystem integration and systems integration laboratory testing of common reasoning algorithm, while continuing to develop algorithms to correlate and fuse CEC data with ISR data processed onboard SSEE-equipped surface ships.

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Communication and Networks | 10,782 | 10,000 | 8,000 | 14,611 |

COMMUNICATIONS AND NETWORKS: This activity supports developing wireless communications network technologies that are critical to the performance and robustness of Naval communications for air, ship, submarine, and land platforms which is critical for network centric operations. Technology 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 benefit of this exploration includes increased network data rates, improved coalition interoperability, dynamic bandwidth management, greater mobile network connectivity, and efficient waveforms to improve communications with land forces.

FY 2002 Accomplishments:
The reliable Multicast Dissemination Protocol transitioned into the Submarine Information Screening and Delivery System and the United States Postal Service, increasing network throughput and reliability. The Optimum Link State Routing (OLSR) protocol for networking and mobility management over heterogeneous networks was developed and simulated, providing increased network connectivity in a mobile environment; field testing of OLSR protocol was performed over a wireless network with several mobile nodes. Dynamic access for satellite bandwidth management underwent initial development and testing in Fleet Battle Experiment India using remote control features of commercial modems, increasing the efficient use of available satellite bandwidth. A demonstration architecture was defined for interoperable networks in a coalition environment involving seven other nations under the international Memorandum of Understanding effort, Interoperable Networks for Secure Communication (INSC). Tactical phased array networking and scheduling algorithms were developed in support of a mobile airborne net to increase the connectivity capacity of airborne platforms using directional, steered phased array antennas for connectivity. Additional progress included design of a new digital receiver architecture and components, including a cross-correlator, that reduce interference. The activity developed a bandwidth efficient waveform using turbo coding and continuous phase modulation (anticipated 100 Kbps data rate over 25 KHz bandwidth) that will result in

approximately a 4:1 improvement in data rate efficiency. The design features adaptive equalization for a Line-of-Sight (LOS) channel with application to the Joint Tactical Radio System (JTRS) and the ARC-210 radio.

FY 2003 Plans:
The activity will develop the Dynamic Backbone Subnet networking protocol suite for mobility management of heterogeneous networks; integrate it with an IEEE 802.11 Wireless Local Area Network (WLAN) device; and field test it in a small, mobile network to determine if there is improved Low Probability of Intercept/Low Probability of Detection for remote users. A dynamic access controller prototype for bandwidth management will also be developed, adapted to Naval satellite channels, and field tested. The INSC effort will include a multinational demonstration of interoperable networks in a coalition environment, including mobility, routing, security, and network management with various application services. Other plans include development of a real-time emulation of tactical phased array networking and scheduling algorithms on a multi-PC networked system, as well as laboratory testing of the emulation. Digital receiver components will be fabricated and tested. Software for a bandwidth efficient waveform (with advanced modulation, coding, and adaptive equalization) will be developed, designed and implemented into prototype modem. A medium access control algorithm to allow multiple submarines to share a single satellite communications channel will be developed, and its performance will be simulated. Planned WLAN development includes integration of low probability of intercept/detection technology with a WLAN to provide wireless network access devices for vulnerable assets. Other near term plans include the design of an optical, tunable, microwave filter for multifunction antennas.

FY 2004 Plans:
The activity will continue experimenting and sharing results from multinational demonstrations of interoperable networks in a coalition environment. Also, an INSC symposium for dissemination and presentation of contributions from each of the memorandum of understanding between the nations will be organized. Field tests will be conducted of the tactical phased array networking and scheduling algorithms, using a small set of mobile platforms and phased arrays. The digital receiver front-end will be integrated on cryocooler for a demonstration of the superconductive digital receiver. This JTRS-compliant receiver (software programmable) can be used to mitigate several classes of cosite interference problems. A prototype modem will be tested over LOS channels (with bandwidth efficient waveform using advanced modulation, coding and adaptive equalization techniques); the waveform design will be provided to JTRS and the ARC-210 radio programs. Additionally, the LPI/D technology will be integrated with a secure Wireless Local Area Network (LAN) to provide wireless network access devices for vulnerable assets and demonstrate this technology. The optical, tunable microwave filter components will be integrated and a fully integrated adaptive microwave filter front-end will be demonstrated for multifunction antennas. Other plans call for evaluating and developing solutions to next generation IP technology to meet Navy/Marine Corps networking challenges particularly mission responsive quality of service; and developing options for addressing existing problems through enhanced capabilities of Internet Protocol (IP) version 6 (IPv6) technology.

FY 2005 Plans:
The activity will continue testing of the next generation IP software solutions and options within Navy, DoD, and coalition networking test beds; investigation of IPv6 and IPv4 network coexistence strategies; and provision of IPv6 technology solutions into USN/USMC IP architectures.

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Network Command, Control and Combat Systems | 24,500 | 22,600 | 18,007 | 23,617 |

NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: This activity area supports FORCEnet and network centric operations through the exploratory development of advanced technologies that contribute to integrated decision-making and mission execution to achieve battlespace superiority. This requires a Common Tactical Picture that is consistent and traceable to the Common Operational Picture. To achieve this, warfighters require: a network infrastructure to accommodate concurrent integrated and parallel processing, an information grid, situation awareness geared toward a user's requirements, self-synchronization, and enhanced speed of command. Efforts to provide advanced high-speed inter theater sealift configurations, in particular projects to mature friction drag reduction concepts will be explored. Overall, the technologies in this activity should enable warfighters to leverage the power of networks to exploit information and information technology as well as maximize the capability of platforms to use information to accomplish missions. The technologies should provide a force multiplier effect and support Joint/coalition combat operations. This activity has six focus areas:(1)information management which addresses technologies to reduce informational demands;(2) image processing and exploitation, which enables image enhancement, feature extraction, and dissemination; (3) visualization technology, which provides improved battlespace views including augmented virtual reality; (4) battlespace decision aids, which assist with optimized planning, assessing, executing, and monitoring military operations; (5) networked command and control (C2) for combat applications, which supports laboratory testing of network centric concepts; and (6) information network situational awareness, which focuses on secure, seamless information exchange within networked systems (weapons, sensors, etc.). Efforts in each area emphasize leading edge concept exploration to support the Navy's vision of Network Centric Warfare.

FY 2002 Accomplishments:
Algorithms were developed to exploit the epipolar structure of a scene from multiple views on tactical imagery efforts. Significant informational features were extracted from video imagery using the Helmholtz Principle and image enhancement proof-of-concept techniques tools which have been adopted by joint imagery systems. The Battlefield Augmented Reality effort developed a metatracker algorithm that switches between multiple sensor inputs. In addition, the effort designed and fabricated a mobile 6 Degrees of Freedom (DOF) high precision virtual reality tracker. Also during FY 2002, the Combat Systems Technology effort demonstrated the missile deconfliction process within the AEGIS High Performance-Demonstration (HiPer-D) environment. An algorithm, prototyped in the HiPer-D environment, was run in real time to assess best shooter based on executable actions and current state of

platform resource allocations and schedules. The Real Time Deconfliction effort evaluated a four-dimensional airspace deconfliction algorithm for AEGIS surface-to-air (SAM) scheduling. The Theater Battlespace Command & Control effort tested three different C2 architectures to include a Common Object Request Broker (CORBA) agent, autonomous agents, and web services integration. This activity designed algorithms to support the Distributed Real-Time Combat Systems (DRCS), an effort focused on delivering real-time signals intelligence (SIGINT) and sensor data to Special Operations Forces (SOF) that usually have constrained devices and transmission bandwidths. The effort developed a static distributed real-time object-oriented database replication algorithm called Just-In-Time Real Time Replication (JITRTR) that generates replication transactions that copy required data where and when it is needed. The algorithms were tested operationally with SOF. The effort also used a dynamic schedulability analysis to ensure that the deadlines of the replication transactions are met.

FY 2003 Plans:
The multi-resolution, multi-scale image registration work continues to address issues in multi-sensor, multi-modal, multi-channel image registration/coordination with applications to precision targeting, image enhancement, change detection and fusion. Techniques that are contrast invariant, automatic, and take into account three-dimensional projective transformations from two dimensional images. Visualization technology plans also include applying computer graphics algorithms to visualize uncertainty for underwater environmental and target data. Real Time Deconfliction effort plans include pre-launch flyout deconfliction. In addition, information network situational awareness plans are to build towards a Common Relevant Operational Picture of the extended Information Battlespace, especially focused on Information Assurance issues. For DRCS, the activity will extend the concepts of the JITRTR algorithm to work in a dynamic environment, such as a Distributed Collaborative Environment, where it is not possible to know about all data access requirements. New algorithms will use an initial estimate of data access requirements to determine when and where to create replicas of the real-time data. The new algorithms will produce replication transactions that make copies of time-critical data in locations where the data will be needed. The DRCS effort will also conduct a limited objective experiment with SOF operators to collect valuable operational information needed to develop the algorithms.

FY 2004 Plans:
Multiresolution and Multiscale Image Processing effort plans include multi-modal image registration. Plans in visualization technology include leveraging Naval Research Laboratory (NRL) Virtual Reality Workbench and Software from NRL and Virginia Tech. Real Time Deconfliction effort plans include real-time operator controls. The Theater Battlespace Command & Control effort plans involve experimentation in comparing all three alternative architectures. The activity will design Quality of Service (QoS) real-time model which enables the expression of time critical concepts and level of QOS. This will be invaluable in FORCEnet and Network Centric Warfare deployments to predict where, when, and why scheduling and network bottlenecks will occur. New techniques for providing improved computer network defense and improved situational awareness are planned. The real time data replication effort will conduct laboratory demonstrations of distributed real-time networked data element replication and conduct cross database comparisons. Other efforts include advanced algorithm development and software tools and decision aids to handle and process large volumes of information.

FY 2005 Plans:
Multiresolution and Multiscale Image Processing effort plans include image registration error analysis. Plans in visualization technology include performing an evaluation to determine the value of 3D techniques. Real Time Deconfliction effort plans include worst-case detection and conflict avoidance. Plans for the Battlefield Augmented Reality System effort include augmenting the real world with computer-generated information. The activity will also design a modular framework to support the system design and enable the insertion of custom scheduling and replication solutions. Other efforts will focus on the middleware layer to support emerging network centric sensor-to shooter systems.

| | FY 02 | FY 03 | FY 04 | FY 05 |
|---|---|---|---|---|
| Human Computer Interface | 9,573 | 5,500 | 5,500 | 5,491 |

HUMAN COMPUTER INTERFACE: This activity focuses on improving platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems. The general objectives of the area 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 with the effect of creating decision-action cycles faster than an enemy's and reducing workload and staffing requirements. Specific objectives include achieving improved situational awareness and speed of command through a deeper understanding of human capabilities and 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.

FY 2002 Accomplishments:
As part of the Command 21 effort, a Knowledge Web and Knowledge Desks were installed in the Tactical Flag Command Center aboard the USS Carl Vinson for use by Commander Carrier Group Three. These decision support systems were used successfully during Operation Enduring Freedom, significantly improving speed of command and collaboration among battle group staff members. Mathematical optimization models that provided support for the Chief of Naval Operations (CNO) Strategic Studies Group on FORCEnet were developed and used to evaluate potential enhancement of command and control team performance in a network-centric environment. In addition, cognitive-based intelligent agent support was developed for aircrew interface with automated subsystems, to improve pilot situational awareness and improve performance under conditions of information overload. Under this effort multinational decision support data and tools were developed for Pacific Command (PACOM) use in the Joint Planning and Execution Community (JPEC). Audio alerting techniques were developed for the Helicopter Aircrew Integrated Life Support Systems (HAIL-SS). New usability engineering processes and principles were produced for virtual environments for complex military software systems. These processes and principles form the foundation for the process of usability engineering for virtual

environments across commercial, military, and other organizations. Visualization tools were developed that make it easier to identify recurrent patterns of information sharing and management.

FY 2003 Plans:
Use influence nets and discrete event models to support Effects-Based Operations during exercises at Joint Forces Command, the Naval War College, and the Joint Warfare Analysis Center. Optimization algorithms will be developed for command and control applications to enhance execution monitoring and dynamic replanning of Naval tactical missions. Computational models will be developed for joint intelligence analysis, as well as shared virtual surfaces for quick-reaction team decision-making. In the near term, development and testing is planned of advanced audio technology and interactive audio management user interfaces for multi-modal tactical workstations. In addition, a model will be developed to describe human-automation interactions with respect to information integration in real-time critical decision-making problems. In addition, simulated devices will be developed for the study of interface design with isomorphic interface control, that is, the ability to swap interface features in and out.

FY 2004 Plans:
Priorities include the development of cognitive computational models of multi-echelon command decision making to define critical knowledge components for command and control. Research to integrate optimization, discrete event and organizational effectiveness models is expected to provide computational formalisms for the design of adaptive architectures for command and control. Coalition teams will benefit from user/agent interfaces for knowledge sharing, and command and control improvements will stem from the development of cognitive models for agent-assisted asynchronous collaboration. Further research is planned to create a generalized template for human-automation interaction for insertion into Naval applications and for development of interface designs that incorporate advanced audio components into multiple task, high-tempo environments. In addition, construction of isomorphic interface controls for three simulated devices will enable the systematic manipulation of the perceptual-motor and cognitive effort required to use each device — essentially creating a cost effective method of simulating human learning and avoiding expensive human testing.

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PROGRAM ELEMENT TITLE: Common Picture Applied Research

FY 2005 Plans:
Development efforts include model-based simulations and experiments that will be conducted to investigate the effectiveness of hierarchical organizational structures in network-centric operational environments in order to evaluate the implementation of FORCEnet concepts. Exploration will continue into reconfigurable organization design structures for culturally diverse decision-making teams; video scene enhancement tools for improved situational awareness; improved designs for integration of audio into Naval applications; and improving the interface designs of simulated devices by comparing the performance of simulated human users with real users in acquisition of knowledge and performance ability.

CONGRESSIONAL PLUS UPS:

| | FY 02 | FY 03 |
|---|---|---|
| Battlespace Information Display Technology | 2,020 | *0 |

*$2,055 (Appropriated in PE 0602234N in FY03).

BATTLESPACE INFORMATION DISPLAY TECHNOLOGY: The Dominant Battlespace Command effort established a state-of-the-art battlespace visualization environment to advance Joint Vision 2020 objectives and the United States Navy's "Forward from the Sea" strategy. Dominant Battlespace Command integrates commercial technologies with emerging Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities, specifically for Navy and Marine Corps battlefield commanders and their staffs. In the absence of proven data correlation and information fusion algorithms, Dominant Battlespace Command visually represented the positions and tracks of ships, aircraft, and ground-based units, along with threat envelopes - in a whole earth, scalable, multi-resolution virtual display linked to intelligence and operational databases. Therefore, Dominant Battlespace Command presented the commander with the battlespace that closely approximates what one sees in their "mind's eye." This realization of the mind's-eye view is expected to result in intuitive actions that transform the 2-D battlespace into a 4-D battlespace so that the warfighter can view events in near-real time and fold in operational aspects associated with time - the $4^{th}$ dimension. In 2002, demonstrated a Dominate Battlespace Command prototype system enhanced with the capability to visualize the common undersea picture during Fleet Battle Experiment Juliet (FBE-J). Additionally, conducted experiments to collect user information from the Navy, Army, Air Force and US Forces Central Command.

| | FY 02 | FY 03 |
|---|---|---|
| Common Sensor Module | 1,927 | *0 |

*$1,368 (Appropriated in PE 0602232N in FY 03)

COMMON SENSOR MODULE:

FY 2002 Accomplishments: Developed of small common sensor modules for ground forces and conduct limited demonstrations.

FY 2003 Plans: Sensors will be networked to provide total situational awareness for the ground forces and to extend the integrated picture to the rest of the forces. This resulting module will be designed as a universal unattended sensor package to meet both USMC and USSOCOM mission needs.

| | FY 02 | FY 03 |
|---|---|---|
| Research In Augmented And Virtual Environment Systems (RAVES): | 0 | 2,444 |

RESEARCH IN AUGMENTED AND VIRTUAL ENVIRONMENT SYSTEMS (RAVES): Develop innovative software, hardware, and prototyping methods for producing effective and robust virtual and augmented reality systems for military applications. Develop algorithms and novel methods for technical areas that provide the underpinning of these systems including computer graphics, machine vision for tracking human body movement and image registration, optics for augmented reality displays, and human/computer interaction for navigation through 3D virtual worlds. Strategies for integrating disparate augmented and virtual environments and scenario generation and after action review tools will be developed. Algorithms and systems will be developed for extracting and understanding information contained in embedded systems that contain large numbers of diverse sensors and computers. Perception-based, multimodal interaction techniques, such as those using voice, gesture, 3D sound, and haptics, will be developed and demonstrated. Evaluation and usability studies will be performed to gain new understanding of the scientific underpinnings of all of the above systems and components. Potential applications include augmented reality systems for the dismounted warfighter, virtual reality systems for training and situational awareness, improved human/computer interaction techniques for situational awareness, medical and scientific visualization, and embedded training in MOUT facilities.

| | FY 02 | FY 03 |
|---|---|---|
| Naval Automation and Info Management Tech | 0 | 2,444 |

NAVAL AUTOMATION AND INFORMATION MANAGEMENT TECHNOLOGY: Reduce the risk associated with advanced IT for information handling and management in support of Expeditionary Warfare by allowing operators to evaluate new technology in operational situations. Efforts for this program include participation in a Joint Forces Command/ II MEF exercise, evaluating key next-generation IT applications and linkages.

| | FY 02 | FY 03 |
|---|---|---|
| National Center for Advanced Secure Systems Research (NCASSR) | 0 | 5,623 |

NATIONAL CENTER FOR ADVANCED SECURE SYSTEMS RESEARCH (NCASSR): Develop an information centric (content-based) approach to security that meets the needs of tactical mobile forces operating in a network centric coalition warfare environment. It will address scalability, access control of information objects and user identification management. The effort is based upon current Information Technology standards and scalable to multiple applications and domains including homeland security collaboration at all levels, critical infrastructure protection, financial and medical information protection.

| | FY 02 | FY 03 |
|---|---|---|
| Submarine Enabling Airborne Data Exchange and Enhancement Program | 0 | 1,467 |

SUBMARINE ENABLING AIRBORNE DATA EXCHANGE AND ENHANCEMENT PROGRAM: Support technologies that facilitate timely exchange of tactical data between airborne and submarine platforms.

| | FY 02 | FY 03 |
|---|---|---|
| Modular Command Center | 0 | 12,470 |

MODULAR COMMAND CENTER: Develop and demonstrate the Mobile Modular Command Center (M2C2) in support of Naval Forces in the Mid-Pacific (MIDPAC) region, specifically at the Pacific Missile Range Facility (PMRF) on Kauai and potentially at the Pohakuloa Army training Range on Hawaii. This program will develop and demonstrate (1) Mobile Modular Command Center (M2C2) leveraging facilities in the Mid-Pacific (MIDPAC) region; (2) Cooperative Engagement Capability (CEC) antenna for Advance Hawkeye; (3) Long Range Theater Ballistic Missile Defense (TBMD) Surveillance at PMRF. The M2C2 will use an Open Network Architecture to integrate Marine communication systems and commercial communications systems into a single integrated picture display which provides real-time situational awareness. M2C2's Network architecture will leverage commercial off-the-shelf hardware for modular implementation.

| | FY 02 | FY 03 |
|---|---|---|
| Tactical Component Network | 34,190 | 29,093 |

TACTICAL COMPONENT NETWORK (TCN) Demonstration: Integrate Tactical Component Network (TCN) at the Pacific Missile Range Facility (PMRF) to support networking for the Navy's cooperative engagement capability demonstrations. Develop integrated modular command posts for various sites at PMRF and integrate both the range sensors with advanced sensors in development using TCN software. This effort includes three tasks: 1) integration of TCN network capability at PMRF and use 3rd fleet assets to further demonstrate a single integrated picture; 2) continuation of the 7th fleet ESSEX ARG installation and demonstration through Cobra Gold (this also includes development of training modules for the fleet); 3) assist in the TCN evaluation in support of Program Executive Office (Theater Surface Combatants) (PEO-TSC) to consider the applicability of an cooperative engagement capability.

| | FY 02 | FY 03 |
|---|---|---|
| Theater Undersea Warfare (TUSW) Initiative | 4,141 | 8,312 |

THEATER UNDERSEA WARFARE (TUSW) INITIATIVE: Using Web Centric ASW as the backbone technology, TUSW will work with the Maui High Performance Computing Center and PMRF to integrate the undersea picture to the single integrated picture.

| | FY 02 | FY 03 |
|---|---|---|
| UESA | *0 | 12,470 |

*$16,320 (Appropriated in PE 0204152N in FY 02)
UESA: Develop and demonstrate a non-rotating, electronically scanned radar technology via a series of land based tests at the Mountain Top (MT) range at the Pacific Missile Range Facility (PMRF), and follow-on flight tests in an appropriate aircraft. Work will include establishing a Radar Test Bed at PMRF.

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:

PE 0601153N (Defense Research Sciences)
PE 0204152N (E-2 Squadrons)
PE 0206313M (Marine Corps Communications Systems)
PE 0602123N (Force Protection Applied Research)
PE 0602131M (Marine Corps Landing Force Technology)
PE 0602271N (RF Systems Applied Research)
PE 0603123N (Force Protection Advanced Technology)
PE 0603235N (Common Picture Advanced Technology)
PE 0603271N (RF Systems Advanced Technology)
PE 0603609N (Conventional Munitions)
PE 0603658N (Cooperative Engagement)
PE 0603640M (Marine Corps Advanced Technology Demonstrations)
PE 0604307N (Surface Combatant Combat Systems Engineering)
PE 0604518N (Combat Information Center Conversion)
PE 0205601N (HARM Improvement)

NON-NAVY RELATED RDT&E:

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

D. Acquisition Strategy: Not applicable