FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: Common Picture Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Common Picture Applied Research	**	124,370	75,594	74,106	69,800	81,232	84,589	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N, and 0602270N.

A (U) 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 developing information as a resource, weapon and target. The need is to develop a high performance network to interconnect geographical distributed surface, subsurface (including electric warship) and air platforms into a unified Naval Force. The Program emphasizes the development of technology supporting real-time planning and execution of Naval Warfare mission ranging from land attack (including expeditionary and littoral warfare) to Joint Theater Operations. These technology developments involve building new embedded capabilities within the Fleet to: 1) locate, extract and integrate relevant, time sensitive, critical information; 2) distribute information tailored to user needs; 3) manage and portray knowledge to the warfighter; 4) enable collaborative decision making among geographically disbursed warfighters; and 5) provide interoperable secure networking among Navy platforms. This program's technology developments directly support Future Naval Capabilities (FNCs) in Knowledge Superiority and Assurance (KSA), Missile Defense, Littoral Anti-Submarine Warfare (LASW) and Platform Protection (PP). The goal is to increase combat power via robust networking of information among distributed naval forces.

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

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

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B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($2,400) DECISION SUPPORT SYSTEMS: Decision Support System supports the Knowledge Superiority and Assurance Future Naval Capability specifically in the area of Decision Support Systems. The emphasis is on developing information and knowledge management capabilities and decision aids to build and maintain a timely operational/tactical picture of the total battlespace across all Command echelons from the Commander in Chief (CINC) to tactical units afloat as well as warfighters ashore. In FY01, delivered geospatial visualization and knowledge management services based on extensible Markup Language (XML) data tagging: allowing interoperability and reuse across multiple data bases. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($1,912) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: This Thrust supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against threat missile systems. The focus of this effort is to develop technologies that could provide these platforms the capability to achieve very accurate hemispheric direction-finding (DF) of radio frequency (RF) signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and Low Probability of Intercept (LPI) detection systems, will provide netted targeting information and cueing that allows for platform self protection against various threat systems. Developments included the use of small compact digital electronics, integrated circuits and digital synthesis technology. The following are examples of projects in this area: the Shipboard Laser Acquisition System (SBLAS), a common laser warning solution for all naval surface vessels that can detect and locate tactical laser threats by indirect scattering as well as direct illumination, successful proof of concept demonstration of single sensor laser-threat warning for large ships and wide area protection for amphibious assault vehicles. SBLAS Critical Design Review (CDR) was successfully conducted and long-lead procurement initiated for system fabrication, delivery and testing under the Platform Protection FNC Electronic Warfare (EW) Integrated System for Small Platforms (EWISSP) program commencing in FY02. The following projects developed EW related technologies that support EW RF and EW Mission Support thrust areas as coordinated by the Defense Reliance Tri-Service Technical Panel for EW S&T. The Tactical Reactive Command & Control Warfare (C2W)/Electronic Attack (EA) Network project develops a self-adapting, spatially distributed EA network for C2W capable of electromagnetic (EM) battlefield dominance through target denial, obscuration and signature alteration. In FY01, the project assembled and tested a C2W Net Emulator, integrated a network C2W/EA concept and completed first field testing. The Adaptive Mixed-Mode Very Large Scale Integration (VLSI) Sensors for Micro Air Vehicles (MAV) project emphasizes development of integrated monolithic or

multi-chip module sensors to allow a MAV to autonomously detect, classify and navigate towards selected emitters and deliver countermeasures or payloads. FY01 saw the development of receiver systems and refined optic flow sensors in preparation for further fabrication and demonstration. The Personal Communications Systems (PCS) Exploitation project, which develops and evaluates technology to exploit and counter (from Navy platforms) modern PCS, conducted a survey of commercial off-the-shelf PCS and Digital Signal Processing (DSP) technology. The Battlefield Ordnance Network Centric Employment project develops and integrates electro-optical infrared (EO/IR) sensor and countermeasures (CM) technology into low cost, light weight unmanned aerial vehicle (UAV) systems to locate and direct counterfire against enemy gunfire, mortars, large caliber weapons, and missiles, and provides real-time imagery with symbology for Network Centric Warfare. In FY01 this project initiated development of coordinated counter-Surveillance/Targeting/Terminal EA techniques to achieve battleforce defense (with available EA assets), continued development of the fuzzy resource manager and an EW architecture that produces self-adaptive force behavior (“Plug-and-fight”) as well as measures of effectiveness (MOEs) for same. The Force Level Simulation project develops, tests and demonstrates concepts for distributed force level simulations over wide area networks. FY01 accomplishments include demonstration of a prototype High Level Architecture (HLA) capable Anti-Ship Cruise Missile (ASCM) simulation and completed prototype of Run Time Interface (RTI) middleware using Object Model Agility design implemented with Defense Modeling and Simulation Office (DMSO) RTI V1.3 implementation. (FY01 accomplishments were funded in PE 0602270N.)

- (U) ($8,916) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION: (FORMERLY TITLED Multi-Source Technology): This thrust focuses on development of technology addressing the Navy’s Surface & Aerospace needs for multi-source integration (MSI), fusion, systems 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. In FY 2001, the program initiated development of Affordable Ground Based Radar technology in response to Marine Corps needs for advanced multi-functional radar capability in Littoral operations. Joint development discussions were initiated and are underway with the Army. Development of System Resource Manager technology was initiated to maximize AEGIS radar (AN/SPY-1D) operational efficiencies in Missile Defense operations. A Joint United States/United Kingdom (US/UK) data fusion technology development addressing interoperability deficiencies was initiated. The program continued the development of platform (E-2C) Multi-Source Integration technology supporting the Missile Defense MSI program. In FY 2001 satellite communications (SATCOM) Input/Output Functionality and Fusion Engine Development was studied and lab demos performed. Electronic Support Measures (ESM) Correlation Algorithm and Human Machine Interface functionality was studied and lab demonstrated. Also continued was the development of Advanced Sensor Networking Technology (ASNT) to enable Cooperative Engagement Capability (CEC)-like networks to add new sensors and capabilities. The development of Composite Combat Identification (CCID) technologies continued with focus on acceleration of EP-3E Story Maker ID

Fusion, and the association of tracks with EP-3E Intelligence, Surveillance and Reconnaissance (ISR) data. (FY01 accomplishments in this thrust were funded in PE 0602232N.)

- (U) ($4,413) COMMUNICATION AND NETWORKS: This area supports the development of key wireless communications network technologies for air, ship, submarine and land platforms critical to the performance and robustness of Naval communications. In FY 01, work was initiated on tasks covering networking of phased arrays, interoperable networks for secure communication and mobility management for heterogeneous networks. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. In order to support mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks, an effort on mobility management for heterogeneous networks was started. It focused on developing routing protocols for tactical, mobile ad hoc networks and also includes mobile internet protocol (IP) development to allow users to seamlessly move from one net to another and reconnect. In order to support allied interoperability over dissimilar networks, a multi-national effort focusing on interoperable networks for secure communications (INSC) was started. INSC is a collaborative research, development and demonstration project focused on internetworking technologies. A total of eight nations participate with their own funding in this effort on tasks dealing with information services, security, mobility, quality of service routing, network management and subnetworks. Within all of these networks it is important to provide a reliable multicast capability to specific groups of warfighters. Our effort on reliable multicast congestion control continued and focuses on increased resource utilization in terms of bandwidth and data rate. This technology will also reduce uncontrolled traffic lockout risks. The tactical data link dynamic networking effort completed in FY01. A Time Slot Reallocation (TSR) protocol was developed and targeted for the Link-16 network. This protocol will dramatically reduce the time for Link-16 participants to enter and exit the system as well as improve the overall throughput. This protocol and associated network management tools will be further developed under the Knowledge, Superiority and Assurance Future Naval Capability starting in FY02. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($19,583) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: This Thrust supports the Navy’s Network Centric Warfare concept by providing battle-space awareness through the management, distribution, and portrayal of information to geographically dispersed decision makers and war fighters. The following technical issues are addressed by this Thrust: 1) development of a seamless information management infrastructure and open architecture that is capable of processing and filtering large amounts of data; 2) the ability to conduct distributed collaborative planning and re-targeting of strike aircraft; 3) development of automated image registration techniques that provides global positioning system (GPS)-equivalent targeting coordinates (3 Meters); 4) development of software technology for advanced visualization systems from high end virtual reality systems (i.e. fully

immersive and responsive virtual reality systems) to desktop personal computers (PCs), personal data assistant (PDAs) and see through goggles; and 5) development of software algorithms for combat systems that provide weapon-target pairing, target deconfliction and distributed weapons coordination among surface shooters. In FY01, work was completed on several technologies that have transitioned into FNC Projects beginning in FY02. Transition accomplishments included: 1) the Real-time Execution Decision Support (REDS) strike mission planning/re-targeting system that is designed to reduce average planning time to less than two hours through use of an open systems architecture and software tools that provide a capability for collaborative planning, real-time situational assessment, plan monitoring/execution and re-targeting of aircraft; 2) image processing and exploitation algorithm that provide geo-registration of multi-channel/multi-resolution images to less than 3 meters; and 3) an optimization algorithm for the Joint Tactical Tomahawk Weapons System (JTTWCS) for selecting an appropriate Tomahawk missile variant necessary to achieve high probability of target-kill. Other accomplishments in FY01 included the following: a successful field test and demonstration of augmented reality goggles with wearable computer that provides the Marines a capability to identify critical landmarks and target coordinates in urban environments; a laboratory test validating a design approach that creates a network-centric architecture for use by the Joint Task Force Commander allowing more effective coordination of Theatre level operations; software agents that retrieve and disseminate tailored information to end users; verification & validation of an end-to-end object model that supports mission critical scheduling with time constraints and quality of service (QoS) guarantees. The Navy payoff for technologies developed by this Thrust will improve speed of command (days to hours to seconds), provide major force multiplier effects and support achievement of self-synchronization of forces through networked information, decision support tools, advanced display technologies and advanced enterprise architectures that are specifically designed to seamlessly connect geographically dispersed war fighting elements in the execution of Naval missions. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($5,500) HUMAN COMPUTER INTERFACE: Work in this area focused on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY01, work was initiated in three areas: the development of improved tools for situation awareness; techniques of dealing with high information load such as knowledge visualization and attention management; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance. Work was continued on the

techniques for improvement of situation awareness, angle of view judgment accuracy, organizational design and decision support for command and control, and improvement of usability and interpretation of tactical displays. Completed tasks include supervisory control tools for tactical task management, and intelligent agent modeling for tactical situation awareness, and the enhancement of user displays for tactical visualization. (FY01 accomplishments were funded under PE 0602233N.)

(U) FY 2001 Congressional Plus-ups:

- (U) ($2,898) BATTLESPACE INFORMATION DISPLAY TECHNOLOGY INITIATIVES DEVELOPMENT DEMONSTRATION (Funded in PE 0602234N): This effort focused on the development of a retinal scanning display for use by the individual warfighter by taking advantage of the size reductions and brightness enhancements that can be obtained by using a low-power laser to write an image directly onto the human eye. Navy/United States Marine Corps (USMC) applications include maintaining the common picture for the dismounted warfighter in urban warfare, aircraft carrier deck operations, and in-the-field maintenance and repair. Initial work is to (1) reduce the power consumption of the display by at least 40% (1700 mW to 1000mW or below) (2) develop a micro electronic mechanical system (MEMS) scanner at Extended Graphic Array (XGA) resolution quality (1024 X 768 diffraction-limited pixels), and (3) perform user evaluation studies to determine which display features (e.g., resolution, field-of-view, stereoscopic, color) are most important for the urban warfighting application.

- (U) ($9,659) Cooperative Engagement Capability Preplanned Product Improvement (CEC P3I) (Funded in PE 0602232N): Effort was directed to cost-effectively equip various fleet assets to determine the extensibility of the cooperative engagement capability (CEC). Specifically, work was performed to develop and demonstrate next generation CEC capability to various 7th Fleet assets, including Essex (LHD, CTF-76), Blue Ridge (LCC, CTF-76), and an AEGIS platform (CTF70) along with ground units from the Marine Corps (CTF-79). Effort at the Pacific Missile Range Facility (PMRF) was to develop next generation CEC units for integration into fleet assets as well as facilitating demonstrations for Theatre Ballistic Missile Defense (TBMD).

- (U) ($1,932) HYBRID FIBER OPTIC WIRELESS COMMUNICATIONS (Funded in PE 0602234N): The program is developing a versatile, mobile, secure communication that represents a marriage between fiber optic and wireless communications. The hybrid communication package incorporates the most desirable features of these two technologies. The specific goal was to develop and prove communications over an aggregate bandwidth of 40 Gb/s using a selectable number of channels. The proposed hybrid optical and wireless communications will provide the military with low-cost, high-capacity, high-speed communications that can simultaneously provide security and mobility. This wideband

communication capability supports a full range of database services, shared computing services, network computing, and shared collaboration.

- (U) ($1,932) OPTOELECTRIC HIGH DEFINITION CAMERA PROTOTYPE (Funded in PE 0602232N): The project is developing a high definition camera for high definition surveillance sensors. Forced Air Unit is developing the camera. The camera will use 4 million gate field programmable gate arrays (FPGAs), and scan progressively at 60 frames a second. It will have over 12 times the number of pixels at twice the frame rate as current camera for video surveillance. The camera's resolution, field of view, color rendition, spectral sensitivity, and frame rate to discriminate targets will meet projected military needs. It will transition to Enhanced Optical Networking (EON) surveillance packages used in ships, drone aircraft and autonomous undersea vehicles.

- (U) ($9,659) TACTICAL COMPONENT NETWORK (TCN) DEMONSTRATION (Funded in PE 0602232N): This project is integrating Tactical Component Network (TCN) at the Pacific Missile Range Facility (PMRF) to support networking for the Navy's cooperative engagement capability demonstrations. The funds are being used to 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 using 3rd fleet assets to further demonstrate 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); and 3) Assist in the TCN cooperative engagement capability of evaluation in support of Program Executive Office (PEO) Theater Surface Combatants (TSC).

- (U) ($1,926) VIRTUAL COMPANY LINK (Funded in PE 0602234N): This effort supports the "Virtual Company LINK" a proprietary trademark of the West Virginia High-Technology Consortium Foundation. The purpose of the work is research to establish a network of commercial businesses in the greater West Virginia economic region that are linked by updated, interoperable computer networks and databases, and supported through partnerships with government agencies and private suppliers and buyers of technology. This network will facilitate the flow of new technology among naval, other government, and commercial applications, and thereby foster robust businesses in the region. One of the Department of the Navy's goals is to reduce the total ownership cost of naval systems by increasing the availability of affordable new technologies through increased commercial activity and use of technologies developed primarily for the commercial marketplace. The work in FY 2001 focused on research toward business portals, webcrawling and websearch engines, database access tools, and intercompany partnerships. This program complements similar efforts in other regions, including the DuPage Technology Research Education and Commercialization Center in Illinois, a plus-up of the Defense University Research Initiative.

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2. (U) FY 2002 PLANS:

- (U) ($26,691) DECISION SUPPORT SYSTEMS: This effort supports technology developments in support of the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC) program. The objective of the KSA FNC is to provide the warfighter with the capability to plan and execute operations that are coordinated across organizations and command echelon, including coalition partners. The Decision Support Systems applied research thrust addresses these KSA needs by technology developments that include a) 21st Century Command, b) Common Picture, and c) Time Sensitive Decision Making. The first addresses operational and theater common picture Naval mission needs by developing knowledge engineering to enable high-intensity joint and naval staffs to effectively acquire, manage, and use large volumes of information in diverse formats. The second focus area (Common Picture) addresses operational and tactical needs of operating forces specifically application of common picture information to the planning, monitoring, and re-planning cycle of operational and tactical force employment. The third area (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. The goal of this thrust is greater speed of command and increased combat power. In FY02, the emphasis continues with the development of information and knowledge management technologies such as: Cryptologic Management and Analysis Support System; Environmental Visualization; Tactical Tomahawk Weapon Control System, Land Attack Missile Fire Control, and Naval Fire Control System Decision Support Capability; and Integrated Decision Support System Product Suite.

- (U) ($1,500) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: Supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no situation awareness (SA) or self-protection against threat missile systems. The focus of this effort is on developing technologies that can provide these platforms the capability to achieve very accurate hemispheric direction finding (DF) of radio frequency (RF) signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and low probability of Intercept (LPI) detection systems, provides netted targeting information and cueing that allows for platform self protection against various threat systems. Developments include the use of small compact digital electronics, integrated circuits and digital synthesis technology. The EWISSP program addresses electronic attack (EA)/situation awareness (SA) subsystem integration and employment technologies for small surface platforms and will be executed in four phases. After applicable EA/SA technologies and solutions are developed and validated under this PE, proof-of-concept hardware and software will transition to PE 0603235N for further integration into systems suitable for capability demonstration under Naval environments and tactical conditions. The technology developments for Compact Small Platform EA and Compact Small Platform SA projects within

the EWISSP program are addressed under this PE. During phase I the threat to small Navy and Marine combat platforms is being defined and the platforms' Concept of Employment (COE) is being reviewed. Trade-offs leading to the definition of performance requirements for an affordable EW system capable of providing substantially increased platform survivability are being conducted. The following subsystems will be developed in parallel: SA, EA, EO/IR and Hybrid radio frequency (RF)/IR Sensor and Countermeasures Decoy Subsystems. The following projects are developing EW related technologies that support EW RF and EW Mission Support thrust areas as coordinated by the Defense Reliance Tri-Service Technical Panel for EW (TPEW) S&T. The PCS Exploitation project is conducting hardware laboratory and flight tests, PCS countermeasure analysis and 2nd generation Specific Emitter Identification (SEI) laboratory measurements. The Battlefield Ordnance Network Centric Employment project is developing an Artificial Intelligence (AI) adaptive controller and testing new multi-platform EA techniques via lab and field experiments. The Adaptive Mixed-Mode VLSI Sensors for Micro Air Vehicles (MAVs) is verifying performance of custom developed Application Specific Integrated Circuits (ASICs) and integrating receivers prior to demonstrating a proof-of-concept sensor. The Tactical Reactive C2W/EA Network project will optimize the C2W/EA network, perform laboratory tests of the developed network and complete the 2nd field test.

- (U) ($8,200) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION (CID): This thrust is focused on development of technology addressing the Navy's Surface & Aerospace needs for multi-source integration (MSI), fusion, systems 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. In FY 2002, the program continued development of risk reduction technology for the Affordable Ground Based Radar. 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. Data streams from multiple radars operating simultaneously must be integrated. Joint development discussions are underway with U.S. Army. (This project will move to PE 0603271N in FY 2003.) The development of the Joint US/UK data fusion technology, which addresses multiple radar fusions and US/UK interoperability deficiencies was canceled for lack of funds. The development of risk reducing technology for application to the platform (E-2C) Multi-Source Integration continues. The program supports the larger effort to improve the E-2C aircraft combat system efficiencies by developing the E-2C MSI. This thrust program has initially investigated the SATCOM Input/Output Functionality problem, the Fusion Engine problem and ESM Correlation problem all related to the Human Machine Interface problem. In FY2002 SATCOM ESM Correlation, algorithms and Human Machine Interface are formally correlated and will be demonstrated in test aircraft. The development of the Advanced Sensor Networking Technology (ASNT) to enable CEC-like networks to add new sensors and capabilities is continued. The development of risk reducing technologies for application to the Composite Combat Identification (CCID) effort continues. Focus is on association of CEC

Networked ESM Classification data with Intelligence, Surveillance and Reconnaissance (ISR) data and the implementation of Joint Tactical Information Distribution System (JTIDS) EW Message for CID Dissemination.

- (U) ($10,580) COMMUNICATION AND NETWORKS: This area supports developing key wireless communications network technologies for air, ship, submarine and land platforms critical to the performance and robustness of Naval communications. Technology developments include QoS protocols, bandwidth and network management 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. In FY 02, work is being initiated on tasks covering dynamic reconfiguration of Link-16, asymmetric secure network access for vulnerable assets, submarine satellite communications (SATCOM) medium access protocol and dynamic access for satellite-based networks. Under the dynamic reconfiguration for Link-16 effort, which is part of the Knowledge, Superiority and Assurance Future Naval Capability, both a dynamic network management tool and a new time slot allocation protocol are being developed. The protocol technologies include a generalized protocol that extends time slot reallocation (TSR) from a single Network Participation Group (NPG) to the entire network and the Stochastic Unified Multiple Access (SHUMA) protocol technology. The potential payoff is a dramatically reduced time to reconfigure the network to allow for entry and exit of network participants (eliminating the two week preplanning process) and to achieve a five-fold throughput improvement by accessing all available time slots instead of leaving them dedicated to network participants that are not present. Our effort under the asymmetric secure network access project focuses on integrating low probability of intercept/detection technology with a secure wireless local area network (WLAN) in order to provide a bi-directional, secure, wireless network access device. This device could potentially be used by Marine Corps vulnerable assets such as special operations forces and unattended ground sensors. This technology will also be provided to the Joint Service Tactical Radio System Project Office as a possible candidate for a handheld tactical radio. In order to improve our submarine communications capability an effort was started to develop a satellite medium access control protocol that would allow three submarines to effectively share a common ultra high frequency (UHF) channel in support of internet protocol (IP) communications. This effort will result in efficient bandwidth management and supports the Chief of Naval Operations (OPNAV) code N6 mandated submarine transition to IP based communications. A project was initiated to provide dynamic access for satellite-based networks on board ships. This effort focuses on bandwidth management for Navy ship SATCOM networks. Networking and bandwidth management technologies are being investigated in order to increase the total information throughput in satellite-based Naval networks and provide critical prioritization and quality of service to warfighters. Our work covering networking of phased arrays, interoperable networks for secure communication and mobility management for heterogeneous networks has continued. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. Automated, distributed algorithms to coordinate

routing and beam scheduling are being developed. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. Our continuing effort on mobility management for heterogeneous networks supports mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks. It focuses on developing routing protocols for tactical, mobile ad hoc networks and also includes mobile IP protocol development to allow users to seamlessly move from one net to another and reconnect. Simulations of specific routing protocols are being conducted. In order to support allied interoperability over dissimilar networks, our multi-national effort focused on interoperable networks for secure communications (INSC) is continuing. INSC is a collaborative research, development and demonstration project focused on internetworking technologies. A total of eight nations participate with their own funding in this effort on tasks dealing with information services, security, mobility, quality of service routing, network management and subnetworks. Some preliminary simulations and laboratory demonstrations of mobility routing are being conducted. Within these networks it is important to provide a reliable multicast capability to specific groups of warfighters. Our effort on reliable multicast congestion control will complete this fiscal year and focuses on increased resource utilization in terms of bandwidth and data rate. This technology will also reduce uncontrolled traffic lockout risks. Simulations of congestion control algorithms are being developed for a reliable multicast protocol.

- (U) ($24,377) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: FY02 plans call for the development of command, control and combat systems technologies that directly support and are critical to the Navy’s network centric warfare concept. The following technical issues are being addressed by this Thrust: the management, extraction, distribution and portrayal of information to decision makers and war fighters; development of advanced multi-resolution images for target identification; near real time and real time mission QoS constraints; a seamless collaborative computing framework capable of supporting operational, systems and technical level collaboration while operating under limited bandwidth, system latencies and unpredictable system interrupts; and software and middle-ware interface requirements for achieving seamless interoperability between command and control and combat systems platforms. In FY02 technology efforts include: 1) the development of “event-condition-alert” rule based algorithms and templates that provide a capability to automatically extract and distribute information to end-users from multiple data sources (i.e. tailored information-push); 2) development of an automated process for creating, disseminating and displaying rules of engagement (ROE) to decision makers and operators; 3) the design, development and prototyping of software algorithms that optimizes tasking-to-platform and weapons-to-target selections for land attack missions; 4) testing and experimentation of an architectural framework and software to provide seamless interoperability and collaboration between theatre level command and control (C2) and combat systems platforms; 5) a joint Defense Advanced Research Projects Agency (DARPA)-Fleet-ONR effort to develop a concept of operations (CONOPS) that utilizes an airborne platform for controlling and managing strike aircraft in the execution of land attack missions. The concept designates the use of an E-2 to perform airborne battle management functions, receive and process target

imagery, and provide en-route strike aircraft GPS-equivalent targeting coordinates. This effort is being coordinated with the Naval Fires Network (NFN) Program Office, Fleet operators and appropriate Program Management offices at Naval Air Systems Command (NAVAIR); 6) development of a computer model and software algorithms capable of estimating mobile target locations during emitting and non-emitting periods; 7) the development of a computer-collaborative framework that supports collaboration among Naval enclaves whether they use legacy client-server architectures or more advanced peer-to-peer processing framework; 8) interoperable protocols and human-computer interface techniques to provide a capability for sharing a common picture and situational awareness among high-end 3D virtual reality systems, PCs, laptops, or a low end hand held displays; and 9) research to define the underlying data structures that will enable statistical information to be rendered graphically for visualizing data uncertainty. Major payoffs from this work will provide: a network centric framework and infrastructure that seamlessly connects war fighters to decision makers with data, information, and a shared situational awareness, thereby achieving a major force multiplier effect through collaboration, coordination and optimization of resources; a substantial increase in the speed of command to near real time; and support for synchronization of Naval forces in the execution of network centric operations.

- (U) ($9,513) HUMAN COMPUTER INTERFACE: Work in this area focuses on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY02, work is being initiated in generative decision support architecture, in knowledge visualization, cognitive models of military decision making domains to improve engineering of decision support tools, and in effects based models for enhancement of surveillance systems. Work will continue in three areas: the development of improved intelligent agents and decision support tools; techniques of dealing with high information load such as knowledge visualization and attention management; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance. These areas will improve command and control, speed critical decision making, and improve human performance in intense, high-tempo and dynamic warfare environments by focusing on the human dimension in the human-computer collaboration, so that warfighters can develop and maintain increased levels of situation awareness and decision making agility through manageable, human-tailored systems that meet their needs in mission critical operations. Work to be completed includes the evaluation of the usability of perspective views

in tactical displays and usability of virtual environment interfaces in comparison with traditional display technology.

(U) FY 2002 Congressional Plus-ups:

- (U) ($2,081) BATTLESPACE INFORMATION DISPLAY TECHNOLOGY: The Dominant Battlespace Command project 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 4th dimension. In 2002, demonstrate a Dominate Battlespace Command prototype system enhanced with the capability to visualize the common undersea picture during Fleet Battle Experiment Juliet (FBE-J). Additionally, conduct experiments to collect user information from the Navy, Army, Air Force and USCENTCOM.

- (U) ($1,982) COMMON SENSOR MODULE: Development of small common sensor modules for ground forces. These 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 will develop prototype modules and conduct limited demonstrations

- (U) ($35,184) 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 PEO (TSC) to consider the applicability of an cooperative engagement capability.

- (U) ($4,262) 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.

3. (U) FY 2003 PLANS:

- (U) ($25,800) KNOWLEDGE SUPERIORITY AND ASSURANCE (KSA)(FORMALLY TITLED Decision Support Systems). This thrust supports the technology development needs of the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC) program. Technology activities include: middleware to enable innovative applications and algorithms to be quickly and cheaply integrated with the Department of Defense Information Infrastructure's Common Operating Environment (COE) software, data management frameworks, specifications for software plug-in of applications and correlators, automated reasoning capability applied to meteorological and oceanographic support for mission planning and execution, and course of action simulation, projection, and assessment, optimization algorithms. The feasibility of these technologies will be evaluated to determine their risk and maturity. Environmental Visualization, Extensible C4I Framework, and Middleware and COE Interoperability will be prototyped and feasibility demonstrations conducted. Investigate for Navy application such as: the application of automated reasoning to surface and sub-surface common picture maintenance; cognitive model-based decision support of mobile time sensitive targets in the amphibious warfare and joint fires support mission context; and adaptive automation to enhance the effective use of scarce assets (such as aircraft and crews) in a joint air mission context. Specific projects planned for FY03 include: Sea Combat Commanders' Module for Embarked Staff, Common Undersea Picture Architecture, Course of Action Analysis Tool for Identifying Mobile Time Sensitive Targets, and Comprehensive, Analytic, Real-Time Execution in Joint Air Operations.

- (U) ($2,000) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: Platform Awareness and Protection supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no SA or EA self-protection against threat missile systems. The focus of this effort will be to develop technologies that can provide these platforms the capability to achieve very accurate hemispheric DF of RF signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and LPI detection systems, provides netted targeting information and cueing that allows for platform self protection against various threat systems. Developments include the use of small compact digital electronics, integrated circuits and digital synthesis technology. The Compact Small Platform EA and Compact Small Platform SA projects continue and will, among other things, provide the flexibility and capability to generate required EA technique waveforms against both non-coherent and coherent radar threat systems to conceal the radar return produced by small

craft, such as the Advanced Amphibious Assault Vehicle (AAAV). They will also provide both autonomous and netted targeting information and cueing to support SA and combat weapon systems. The EWISSP program addresses EA/SA subsystem integration and employment technologies for small surface platforms and is being executed in four phases. EA and SA aspects are addressed under this PE. EWISSP Phase II will commence in FY03. During this phase, detailed EWISSP subsystem designs will be developed and implemented physically. Although the subsystems may be designed and developed separately, they must provide for compatible integration and platform interface in Phase III (system integration), which is planned to commence in FY05. Subsystem hardware and software performance will be successfully demonstrated to defined levels in a laboratory/field environment at the end of this phase as well as compatibility with existing and/or planned basic physical and electrical designs and features of host platforms. The Battlefield Ordnance Network Centric Employment project will evaluate data compression and transmission schemes and complete development of the detection algorithm framework and realtime processor. The Tactical Reactive Command and Control Warfare (C2W)/EA project will analyze and optimize hardware for the 3rd field test (proof-of-concept demonstration) and identify concept performance and enabling technology factors. Receiver systems and refined optic flow sensors will be developed under the Adaptive Mixed-Mode VLSI Sensors for MAVs. The PCS Exploitation project will complete and test all hardware and CM techniques.

- (U) ($7,900) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION (CID): This thrust focused on development of technology addressing the Navy's Surface & Aerospace needs for multi-source integration (MSI), fusion, systems 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. In FY 2003, the program will continue development in the risk reducing technologies to support the platform (E-2C) Multi-Source Integration effort. This is a software development effort. In FY 2003, a phased plan provides for support for near-term fleet benefits in this fiscal year and later out years. This thrust program will support this plan with development of risk reducing software technology. The development of the Advanced Sensor Networking Technology (ASNT) to enable CEC-like networks to add new sensors and capabilities will continue. The development of risk reducing technology supporting the Composite Combat Identification (CCID) will continue. Emerging technologies potentially superior to the Cooperative ID and Non Cooperative ID presently integrated into the CCID program will be pursued.

- (U) ($1,600) LITTORAL ANTI-SUBMARINE WARFARE (ASW): This Littoral ASW Discovery and Invention (D&I) program supports the Littoral ASW FNC. The emphasis is on developing a common ASW tactical and environmental picture to improve detecting, tracking, and classifying subsurface platforms. This project will develop technology to support cross platform Command & Control and Tactical level data fusion, decision aids and display for ASW and thereby improve input to and construction of the common tactical and environmental ASW picture. Network-centric warfare is

recognized by many studies as the future of US defense forces. Network-centric ASW is difficult to implement because of restricted connectivity to submarine platforms and bottom-deployed systems. Advances in data fusion, decision aid, and display technology are needed to fully achieve ASW network-centric warfare. The project will be initiated in FY03. The initial task of the effort will be a system requirement analysis that will set system goals for technology development. In addition, a technology assessment will also be initiated to define high payoff technologies for further development. Planning for data collections to support algorithm development will begin with a data collection event occurring in the first part of FY04.

- (U) ($7,000) COMMUNICATION AND NETWORKS: This area will support development of key wireless communications network technologies for air, ship, submarine and land platforms that are critical to the performance and robustness of Naval communications. Technology developments include Quality of Service (QoS) protocols, bandwidth and network management techniques for robust highly dynamic environments, interoperable wireless networks for secure communications, protocols, and bandwidth and network management techniques for managing and allocating bandwidth across wireless tactical networks. In FY03, work will continue on tasks covering networking of phased arrays and multi-national virtual operation capability. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. The emphasis is on developing automated, distributed algorithms to coordinate routing and beam. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. The Virtual Operations Network (VON) continues and seeks to develop and experiment with the required technologies to provide Maritime multinational coalition forces with the capability to conduct timely and relevant information exchanges over IP networks at sea. Security technology development under this effort will be integrated with related ONR, DARPA, other service, or multinational partner network technology developments in order to continue to enhance multinational network interconnects and minimize network infrastructure required to allow multi-level networking. VON is coordinated with and supports the Chief of Naval Operations Allied Interoperability Strategy, the maritime component of the multinational Combined Communications Electronics Board (AUSCANNZUKUS), North Atlantic Treaty Organization (NATO) Command, Control and Communications (C3) Agency, DARPA Dynamic Coalitions program, CINCPACFLT, and is conducted jointly with the UK MoD. Our work covering dynamic reconfiguration of Link-16, asymmetric secure network access for vulnerable assets, submarine satcom medium access protocol, dynamic access for satellite-based network, and mobility management for heterogeneous networks will complete during FY03. A dynamic network management tool and a new time slot allocation protocol will be completed and simulated for Link-16. The goal is to reduce time to reconfigure the network to allow for entry and exit of network participants and to improve throughput by accessing all available time slots. Our effort under the asymmetric secure network access project will focus on integrating low probability of intercept/detection technology with a secure wireless local area network (WLAN) in order to provide a bi-directional, secure, wireless network access device. In FY03, Marine Corps

vulnerable assets such as special operations forces and unattended ground sensors could potentially use this device. This technology will also be provided to the Joint Services Joint Tactical Radio System Joint Project Office as a possible candidate for a handheld tactical radio. Work will be completed on development of a satellite medium access control protocol that would allow three submarines to share a common UHF channel in support of Internet protocol (IP) communications. This effort will result in efficient bandwidth management and supports the OPNAV N6 mandated submarine transition to IP based communications. A project to provide dynamic access for satellite-based networks on board ships will be completed. This effort will focus on bandwidth management for Navy ship SATCOM networks. Networking and bandwidth management technologies will be investigated in order to increase the total information throughput in satellite-based naval networks and provide critical prioritization and quality of service to warfighters. Our effort on mobility management for heterogeneous networks will be completed in FY04 and supports mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks. It will focus on developing routing protocols for tactical, mobile ad hoc networks and includes mobile IP protocol development to allow users to seamlessly move from one net to another and reconnect. Simulations of specific routing protocols will be completed.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

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

(U) ($24,723) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: This Discovery and Invention thrust in FY03 will continue to develop software technologies and modify commercial of the shelf (COTS) products for military application that provide: improved enhanced situational awareness; sharing of a common picture among command echelons; seamless interoperability among computing platforms, systems and geographically dispersed war fighters; and automated decision aids that optimizes the use of resources and further reduces planning cycle time. FY03 plans will emphasize developments of software algorithms and security techniques that will provide high assurance computing and dependable information, real time middle-ware for dynamic and timely scheduling of resources with enforced operational constraints, enhanced image processing algorithms for target identification, protocols for secure interoperable data exchange among coalition forces, completion of the rule-based (event-condition-alert) algorithms for actively pushing tailored information to users, and assessing the value-added of using 2D versus 3D display systems on board submarine platforms. Additionally, work will continue on tasks covering theater battle management for command and control, battle-space decision aids such as rules of engagement and land attack pre-designation weapons optimization, and development of advanced visualization technologies such as auto-stereoscopic 3D displays that can be viewed without the use of goggles. Further, a new initiative with the Naval Warfare Development Command (NWDC) will be pursued to investigate the utility and benefits of using existing networks such as Defense Research and Engineering Network (DREN) to conduct collaborative experiments among performing activities. Experiments will be specifically designed to test and evaluate technologies developed for network centric applications. The effort is intended to define MOEs and performance (MOPs), identify experimental objectives and integrate and test maturing technologies into enterprise architectures designed for network centric operations. The payoff for the Navy will be a marked improvement in speed of command and self synchronization of forces in the execution of Naval missions.

- (U) ($6,571) HUMAN COMPUTER INTERFACE: Work in this area will focus on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY03, we will initiate work on the development of cognitive models for the prediction of user performance in different types of visual and audio display technologies. Work will continue on tasks in the development of improved tools for situation awareness; in effects based models for enhancement of surveillance systems techniques of dealing with high information load such as knowledge visualization and attention management; cognitive models of military decision

making domains to improve engineering of decision support tools; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President's Budget	**	83,557	
(U) Adjustments from FY 02 PRESBUDG:			
Section 8123 Management Reform Initiative Reduction		-1,109	
Congressional Reduction for Transformation Priorities		-1,912	
FFRDC Reduction		-66	
Congressional Plus ups		43,900	
(U) FY 2003 President's Budget Request:		124,370	75,594

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N, and 0602270N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

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

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E: The Navy's 6.1 program contributes to this effort.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: Common Picture Applied Research

(U) NAVY RELATED RDT&E:

- (U) PE 0204152N (E-2 Squadrons)
- (U) PE 0206313M (Marine Corps Communications System)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602123N (Force Protection Applied Research)
- (U) PE 0602271N (RF Systems Applied Research)
- (U) PE 0602131M (Marine Corps Landing Force Technology)
- (U) PE 0603114N (Power Projection Advanced Technology)
- (U) PE 0603123N (Force Protection Advanced Technology)
- (U) PE 0603235N (Common Picture Advanced Technology)
- (U) PE 0603271N (RF Systems Advanced Technology)
- (U) PE 0603609N (Conventional Munitions)
- (U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)
- (U) PE 0603658N (Cooperative Engagement)
- (U) PE 0604307N (Surface Combatant Combat System Engineering)
- (U) PE 0604518N (Combat Information Center Conversion)

(U) NON NAVY RELATED RDT&E:

- (U) PE 0602204F (Aerospace Sensors)
- (U) PE 0602702F (Command, Control and Communications)
- (U) PE 0602782A (Command, Control and Communications (C^3) Technology)

E. (U) SCHEDULE PROFILE: Not Applicable.