Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602235N COMMON PICTURE APPLIED RESEARCH					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	105.732	85.209	83.163						Continuing	Continuing
0000: COMMON PICTURE APPLIED RESEARCH	105.732	85.209	83.163						Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric S&T investments. The program focus is on S&T enabling technologies that provide decision making and mission execution to achieve battlespace superiority. Program activities seek to develop hardware and software technologies that (1) identify and integrate informational content from multimedia sources including images, and intelligence sources; (2) integrate massive amounts of information; and (3) provide automatic correlation, fusion, and insight to support user-cognitive processes. Particular programmatic emphasis will be placed on automating the association of objects and events in the battlespace and automatically transforming this information into actionable knowledge (e.g., indications and warnings of intent). In current and future operational environments such as Overseas Contingency Operations (OCO) and Maritime Domain Awareness (MDA), warfighters require technologies evolved to support information needs regardless of location and that are consistent with the user's level of command or responsibility within varying operational situations. Net-centric operations include communications and information assurance capabilities to enable all-source data access, multi-source processing, and tailored dissemination of information to Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) users across the network. The operational benefits sought are increased speed of response, accuracy and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority. Technologies emphasized provide warfighters with a robust, secure, mission responsive network; integrated information leading automated courses of action; and presentation of knowledge to speed understanding. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

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This program explores and demonstrates technologies that enable options for the Navy's FORCEnet, Sea Shield, and Sea Strike pillars and contains investments in the following Enabling Capabilities (ECs): Combat Identification (ID) Information Management of Coordinated Electronic Surveillance, Automated Control of Large Sensor Networks, GWOT Focused Tactical Persistent Surveillance, Globally Netted Joint/Coalition Force Maritime Component Commander, Dynamic Tactical Communications Networks, Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC), High-bandwidth Free-space Lasercomm, Actionable Intelligence Enabled by Persistent Surveillance, and Real-Time Long Range Air Defense Combat ID in Support of Early Engagement. In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet (Persistent Intelligence, Surveillance, and Reconnaissance; Time Sensitive Strike; and Sea Based Information Operations), Sea Strike (Ship-to-Objective Maneuver), and Sea Shield (Theater Air and Missile Defense).

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

B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	103.751	77.054	83.719	
Current BES/President's Budget	105.732	85.209	83.163	
Total Adjustments	1.981	8.155	-0.556	
Congressional Program Reductions		-0.319		
Congressional Rescissions				
Total Congressional Increases		8.500		
Total Reprogrammings	2.790			
SBIR/STTR Transfer	-0.809			
Program Adjustments			0.070	
Rate/Misc Adjustments		-0.026	-0.626	

Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **ADVANCED PANORAMIC SENSOR SYSTEMS FOR UAVS**	0.772	0.000
Project: 9999, **ALL WEATHER SENSE & AVOID SENSORS FOR UAVS**	2.317	2.492
Project: 9999, **LAYERED SURVEILLANCE/SENSING**	0.000	1.596
Project: 9999, **M2C2**	3.085	0.000
Project: 9999, **RADIO SENSOR MODULE (RASM)**	1.543	0.000
Project: 9999, **SENSOR INTEGRATION FRAMEWORK**	0.000	1.197
Project: 9999, **SOF TEST ENVIRONMENT FOR ADV TEAM COLLABORATION MISSIONS**	0.000	1.995

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Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **THEATER UNDERSEA WARFARE INITIATIVE (TUSW)**	3.099	0.000
Project: 9999, **UNMANNED GROUND VEHICLE (UGV) MOBILITY & COORDINATION IN JOINT URBAN/LITTORAL ENVIRONMENTS**	0.772	1.197

Change Summary Explanation

Technical: Not applicable

Schedule: Not applicable

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
COMMUNICATION AND NETWORKS	8.989	9.417	8.226	

The overarching objective of this activity is to develop high throughput dynamic wireless communications and networks technologies critical to the mission performance and robustness of naval communications for widely dispersed mobile air, land, surface and submerged platforms. These platforms are often size, weight and power (SWaP) limited, and will operate under constraints of cluttered RF spectrum, harsh electro-magnetic interference (EMI) and Beyond Line Of Sight (BLOS) conditions. The technical payoff is increased network data rates, interoperability across heterogeneous radios, dynamic bandwidth management, and greater mobile network connectivity. The operational payoff is that warfighters from the operational command to the tactical edge have near real-time access to information, knowledge and decision-making necessary to perform their tasks, including coalition and allied forces. Emphasis is on tactical edge communications and networks to fully realize net-centric warfare, bridging the GIG and the 'disadvantaged user', e.g., small-deck combatants, submarines, unmanned vehicles, distributed sensors and ground units in urban and radio frequency (RF) challenged environments. The current specific objectives are:

a) Radios and Apertures: Develop technologies for high band radio, electrically-small and actively-scanned antennas, addressing critical issue of radio spectrum bandwidth efficiency, spectrum contention and clutter, agile frequency communications with dynamic spectrum access, all-digital front-end with wide dynamic range, power amplifier efficiency, multipath effects, saltwater propagation and BLOS communications. Develop algorithms and signal processing for space-time-frequency diversity communications, including measures for electronic protection, such as low-intercept anti-jam waveforms and modulation. Develop affordable antenna technologies for small size and weight, high radiation efficiency, and wideband operation with rapid beam-steering. Develop alternatives to RF communications in airborne and terrestrial environments as well as high data rate underwater communications for undersea warfare (distributed sensors netting, unmanned underwater vehicle data exfiltration, submarine Communications at Speed and Depth) using electro-optic/infra-red (EO/IR) technologies. Develop secure, high bandwidth communications systems and the exploitation of existing and emerging network protocols that will avail development of new Low Earth Orbit (LEO) based data transport mechanisms.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
b) Tactical Networking and Network Control/Management: Develop advanced networking techniques for robust, highly dynamic environments; interoperable networks for secure communications and protocols, bandwidth and network management techniques that manage and allocate bandwidth across tactical and theater levels in support of net-centric operations. Develop rapidly auto-configuring and self-organizing networks with efficient and survivable routing, secure authentication, mobility management and Quality-of-Service guarantee while optimizing network resources. Address low bandwidth, synchronization and reliability for Service Oriented Architecture (SOA)/middleware architecture in both mobile ad-hoc networks (MANET) and infrastructure-based Internet Protocol (IP) backbone networks. Develop cognitive network planning and operations engines whose criteria are based directly on mission objectives while self-adapting and managing the spectrum allocation and radio resources in such a way that network operations, SOA community of interest, and computer network defense are integrated to form a single common tactical network picture that requires a minimum of human intervention and skill. Develop technology for improving tactical edge networking and for improving voice communications. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2008 Accomplishments:* Radios and Apertures: - Continued efforts to mature the superconducting cross-correlator to technology readiness level 4 to enable the development of a multi-function multi-net digital-Radio Frequency dehopping receiver for Link-16. This involves the integration of High Temperature Superconductors analog and Low Temperature Superconductors digital circuits in a COTS two-stage cryocooler. - Continued project to architect multi-Mega bits per second (Mbps) naval laser communication system for ships. Designed rate-adaptable optical receiver using avalanche photo-diodes and array-detection techniques for improved performance in poor weather conditions. - Continued Broadband Electronically-steerable Array for Mission Security (BEAMS), a low cost analog beam forming and steering technique for UAV to UAV and UAV to ground station communications. - Continued development of an adaptive rate terminal to maintain laser communications in poor weather conditions.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued the development of free space hybrid Infrared laser communications links with greater than 10X bandwidth of digital link for same power. - Continued development of digital beam forming and steering for small UAVs in upper Ka band (38 GHz), including Risley prism conformal antennas and lightweight switched beam antennas made of composite materials. - Continued development of small foot-print, low-power fly-by optical communications underwater between unmanned underwater vehicles (UUV)/unmanned surface vehicles (USV) and bottomed sensor field, utilizing blue-green directly modulated semiconductor lasers. - Continued development of submarine to UUV/USV/sensor comms using underwater Modulating Retroreflector technology. - Continued techniques for ultra-wide band (UWB) range extension by time reversal and other methods, including receiver prototyping. - Continued development of low-cost integrated stub antenna and ferroelectric phased array technology for directional communications. - Continued the development of pattern recognition algorithms to allow detection and identification of intruders into remote or urban areas. - Continued the development of technical characteristics of a Communications Electronic Attack (EA) system that consists of a master EA platform that operates in concert with a network of simple subordinate platforms. - Completed prototyping of the high data rate (HDR) communications (> 1 Gbps data links) for small tactical UAVs in ISR applications, meeting the size, weight and power requirements. - Completed development of an UWB groundwave communication transceiver and high frequency (HF) antenna for a distributed sensor network and gateway buoys. - Completed development of a concept for recovering GPS signals in a "friendly" jamming environment thus allowing GPS to be used while denying that capability to an adversary. - Initiated development of underwater Extremely Low Frequency (ELF) antenna and RF technology for submarine comms at speed and depth. - Initiated development of metamaterial structures and periodic inductive and capacitive loading for submarine High-Frequency Internet Protocol (HF-IP) buoy-cable antennas (BCA).				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Tactical Networking and Network Control/Management: - Continued development of Robust Airborne Networking Extensions (RANGE) for joint battlespace networking, networking UAVs, and hybrid mobile ad hoc networking (MANET)/satellite operation. Implemented MANET protocols for cross-layer optimized routing, including disruption tolerant networking to sensors and platforms. - Continued development of advanced topology and medium access control (MAC) for extremely low power consuming sensor networks. - Completed development of RANGE protocols and software kit for dynamic inter-UAV networking. - Completed development of protocols and algorithms for mobility and security in emerging IPv6 next generation MANETs. - Initiated development of service oriented networking protocols and middleware for the tactical warfighter and platforms. - Initiated the development of wireless-ready, reliable data transport technologies suitable for tactical-edge and afloat networks. *FY 2009 Plans:* Radios and Apertures: - Continue all efforts of FY 2008 less those noted as completed above. - Complete prototyping of the conformal array for digital beam forming and steering on small UAVs in upper Ka band (38 GHz). - Complete development of small foot-print, low-power fly-by optical communications underwater between UUVs/USVs and bottomed sensor field, utilizing direct modulated semiconductor lasers or modulating retro-reflectors (MRR)in the blue-green band. - Complete prototyping of receivers that demonstrate UWB range extension by time reversal methods. - Complete the development of free space hybrid Infrared laser communications links with greater than 10X bandwidth of digital link for same power. - Complete the development of pattern recognition algorithms to allow detection and identification of intruders into remote or urban areas. - Initiate development of Line of Sight (LOS) high data rate UAV-sensor communications for expeditionary forces.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiate development of advanced signal processing, coding and switching amplifier techniques for high power amplification. - Initiate metamaterials based dish antennas development for Ka-Ku band satellite communications (SATCOM). - Initiate development of low intercept and low probability of Detection (LPD), jam resistant communications/networks for distributed nodes. - Initiate blue-green fiber laser technology development for space-based submarine communications. Tactical Networking and Network Control/Management: - Continue all efforts of FY 2008 less those noted as completed above. - Complete development of advanced topology and MAC for extremely low power consuming sensor networks. - Initiate development of network coding and cognitive radio networking technologies with heterogeneous links. *FY 2010 Plans:* Radios and Apertures: - Continue all efforts of FY 2009 less those noted as completed above. - Complete ultra wideband time reversal technique improvement, up to a factor of 2 compared to when channel estimation techniques are not used. - Initiate development and demonstrate electrically small antennas at VLF/HF, as well as lightweight beam steering antennas for UAVs using switched (ferrite) multi-horns and Risley prisms with 15-30 dB gain and 1.5 GHz bandwidth in the 38 GHz band. - Initiate design and development of low observable jam resistant waveform, including directionalization, for advanced tactical data links. - Initiate design and development of electronic protection for HF communications. Tactical Networking and Network Control/Management: - Continue all efforts of FY 2009 less those noted as completed above.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate development of a SOA-based secure tactical wide area network for coalition forces, showing independence of coalition tactical communications from satellite backhaul, bandwidth management and service discovery. - Initiate development of topology control, discovery mechanisms and directional networking for free-space optical links. - Initiate demonstrations of pattern recognition algorithms to allow detection and identification of intruders into remote or urban areas; develop technical characteristics of a Communications Electronic Attack (EA) system that consists of a master EA platform that operates in concert with a network of simple subordinate platforms; develop wireless-ready, reliable data transport technologies suitable for tactical-edge and afloat networks. - Initiate design and development of cognitive netops for tactical communications.					
COMPUTATIONAL FRAMEWORK AND METHODS FOR RAPID ACCURATE DECISION MAKING (FORMERLY NETWORK COMMAND, CONTROL AND COMBAT SYSTEMS) The goal of this activity is to support FORCEnet by developing enablers for decision making and mission execution to achieve battlespace superiority. It focuses on the development of algorithms and software technologies that identify and integrate informational content from multiple sources, leading to decision aids that support user-cognitive processes. Because persistent sensors are generating massive amounts of data, the focus is on technologies that not only integrate information from diverse sources, but also provide indications of information significance in ways that support the user's decision needs regardless of location and operational situation. To achieve this, it must be possible to automate understanding of the battlespace by identifying objects, determining relationships among the objects, assessing intent, and automatically generating courses of action with associated risks and uncertainty. Effort will also be devoted to developing technology for increasing assurance and security for C3 information systems and technology for improving information discovery and information presentation in such systems. The current specific objectives are: a) Automated Intelligence Tools: Develop automated image and signal intelligence understanding tools based on rigorous mathematical and statistical methods that lead to improved change detection, improve		24.084	23.950	25.532	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**

object and activity detection and recognition capabilities, context and scene understanding, and inferring of the threat levels to support decision making and persistent and adaptive surveillance.

b) Battlespace Sensor and Intelligence Integration: Develop innovative methods for combining traditional and non-traditional data from sensors and disparate sources to provide the best estimate of objects, events, and conditions in the battlespace, in terms of their identity, associated error or uncertainty, context, impact, and infer relationships and their intentions.

c) Automated Reasoning Methods and Models for Situational Analysis: Develop rigorous and efficient methods for building sophisticated situational models, develop automated reasoning techniques to categorize and recognize situations under a variety of conditions leading to methods that predict situations under different settings.

d) Automated Decision Tools: Develop automated decision tools based on mathematically rigorous techniques (e.g., mathematical optimization) that support decision-making to ensure the best use of scarce and/or expensive resources to achieve optimal allocations for large complex scenarios, including ones that contain uncertainty, in drastically reduced amounts of time. Develop methods that support decision making in networked sensor management and allocation to ensure sensor assets are deployed in an optimal or near optimal manner.

e) Secure Sensor Networks: Develop tools and methods to securely handle information without exposing intelligence information about the networks or systems to adversaries.

The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.

FY 2008 Accomplishments:
- Automated Intelligence Tools:
- Continued the demonstration and conducted image registration error analysis for the multi-resolution and multi-scale image processing effort.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued development of automated methods for identifying significant changes between temporally separated images (not video) to extend work on automatic target recognition and pattern recognition into change detection algorithms. - Continued efforts in automated image understanding that use active computations and visual pattern recognition for networked target recognition systems in maritime domain awareness. - Continued development of semi-supervised detection algorithms for multi-sensor imagery, video and human intelligence that will enable self-deploying sensor networks. - Continued development of a scalable system design for coordinated Unmanned Aerial Vehicle (UAV) formation control that integrates onboard and off-board sensor data. - Continued development of interactive image/video-based surveillance systems for perimeter protection, and port protection. - Completed the development of a feature extraction module that segments the video based on video mosaicing. - Completed the development of algorithms with Naval/Joint imagery systems to handle video metadata, which includes Global Positioning System, time, and sensor information. - Completed the development of recommendations for standardizing the storage and linking of feature descriptions within a common database framework. - Completed development of technology to improve collaborative operational planning for tactical users using Head-Up Displays. - Initiated the development of a new radar signature analysis technique based on nonlinear dynamics. - Initiated the development of a novel particle filter-based elevation angle tracking algorithm to improve the capability to track low-angle targets over the sea surface under multipath conditions using passive sensors. - Initiated the development of the theory and technology for near-field electromagnetic (EM) phenomenology relevant to high resolution, through-the-wall imaging at close ranges in urban operations. Battlespace Sensor and Intelligence Integration: - Continued the development of a Case-Based Reasoning simulation/model for implementing situation, threat awareness fusion solutions and a Bayesian Network inference engine for manipulating uncertainty and learning from data.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued development of technology for improving voice data interpretation and presentation to cope with audio information overload in Navy Systems. - Continued demonstration of a trusted data store which maintains data pedigree and detects anomalies in a limited objective experiment. - Continued efforts in Joint Director of Laboratory's Data Fusion Model Level 1/2/3 data fusion using abductive reasoning, Bayesian networks, agent-based techniques, statistical-based methods, and other approaches. - Continued efforts in the automated integration of disparate sources of information that involve data mining methods and game theory. - Continued development of an interface between the Level 1 and Level 2/3 data fusion processes across federated service oriented architectures. - Continued development of new data schemas and methods to allow more efficient assembly of a common operational picture (COP) integrating informational content from images, track data, intelligence and incomplete track data. - Continued Level 1 fusion algorithm and architecture design with associated ontology to manage information from automated sensors to provide a more dynamic and accurate battlespace picture through improved object refinement. - Completed the development of algorithms and demonstration of data reduction through joint classification and feature optimization, realizing transfer of data to information, realizing A/I vis-a-vis Analog/Digital data (reduced bandwidth requirements and reduced burden on analysts and warfighters). - Completed the development and characterization of new target detection and recognition algorithms to exploit higher dimensional data (spatial, temporal, and spectral) within the Network Centric Warfare framework. Approach uses advanced correlation approaches to provide improved target detection and recognition performance by integrating multiple sensor measurements. - Completed the development of a suitable ontology for exercising large-scale distributed situational threat awareness in Naval battlespace environments. - Completed the augmentation of the real world information with computer-generated information in the Battlefield Augmented Reality System effort. The activity designed a modular framework to support the system design and enables the insertion of custom scheduling and replication solutions. Other efforts focused on the middleware layer to support emerging network centric sensor-to shooter systems.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated the development of software and algorithms for integrating the functions of target acquisition, tracking, data computation, and engagement control across multiple platforms for engaging multiple threats. - Initiated the investigation of service oriented methods to automatically retrieve relevant information for a community of interest. - Initiated the development and testing of the Joint Integrated Fires Control effort. Automated Reasoning Methods and Models for Situational Analysis: - Continued demonstration of predictive surface platform threat behavior algorithms and software employing techniques using pattern recognition on geospatial and attribute data. Also developed autonomous monitoring and reporting of high interest and anomalous maritime vessels. - Continued development of methods for automated generation of courses of action, including techniques for automated planning and reasoning in uncertain environments. - Continued efforts in ontology-based information fusion for enhanced situational awareness and classification-based knowledge discovery. - Continued demonstration of anomaly detection, feature-based target tracking, track-to-pattern association and scoring, track-to-group clustering, pattern discovery and learning, pattern templates/ descriptions and predictive modeling tools in a limited objective experiment. Automated Decision Tools: - Continued development of sensor management algorithms that reduce the amount of labeled training data required, employing semi-supervised classifier and active learning techniques motivated by asymmetric threat, which limited training data anticipated. - Completed demonstration of a FORCEnet limited objective experiment involving the application of new techniques of discrete optimization, statistical discrimination, and artificial intelligence for the resource allocation of weapons. Compared initial results with high fidelity physics based models for threat and anti-threat weapon systems for continued development of Anti-Air Warfare optimization algorithms. - Initiated the development of methods for selecting sensors and platforms for search and surveillance operations in a theater, allocating the selected sensors and platforms to specific missions, operating the allocated sensors during a mission, and fusing the information from the sensors and other sources.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Secure Sensor Networks: - Continued the development of an initial prototype for an information sharing infrastructure that maintains data integrity and confidentiality for enclaves of networked workstations running Commercial Off the Shelf (COTS) operating systems and applications. - Continued development of technology to improve reliability of systems to survive Information Warfare attacks. - Continued development of technology for improved steganography and watermarking. *FY 2009 Plans:* - Automated Intelligence Tools: - Continue all efforts from FY 2008 less those noted as completed above. - Complete development of automated methods for identifying significant changes between temporally separated images (not video) to extend work on automatic target recognition and pattern recognition into change detection algorithms. - Complete efforts in automated image understanding that use active computations and visual pattern recognition for networked target recognition systems in maritime domain awareness. - Complete development of a scalable system design for coordinated Unmanned Aerial Vehicle (UAV) formation control that integrates onboard and off-board sensor data. - Initiate development of coordinated multi-platform, multi-component waveforms. - Initiate development of a real-time electronic warfare support deinterleaving capability. - Initiate development of advanced communications emitter identification. Battlespace Sensor and Intelligence Integration: - Continue all efforts from FY 2008 less those noted as completed above. - Complete the development of a Case-Based Reasoning simulation/model for implementing situation, threat awareness fusion solutions and a Bayesian Network inference engine for manipulating uncertainty and learning from data.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete efforts in Joint Director of Laboratory's Data Fusion Model Level 1/2/3 data fusion using abductive reasoning, Bayesian networks, agent-based techniques, statistical-based methods, and other approaches. - Complete efforts in the automated integration of disparate sources of information that involve data mining methods and game theory. - Complete development of technology for improving voice data interpretation and presentation to cope with audio information overload in Navy Systems. - Initiate approaches and tools for (semi)-automated data integration and reasoning about information from diverse sources in ways that support decision makers with timely, actionable information at operational and tactical levels of command, with an emphasis on missions that are related to OCO and force protection. Automated Reasoning Methods and Models for Situational Analysis: - Continue all efforts from FY 2008 less those noted as completed above. - Complete ontology-based information fusion for enhanced situational awareness and classification-based knowledge discovery. Automated Decision Tools: - Continue all efforts from FY 2008 less those noted as completed above. - Complete sensor management algorithms that reduce the amount of labeled training data. - Initiate development of algorithms to optimize the selection from disparate and multiple information sources as well as the characterization of related pedigree over multiple user processing requests within extremely large data sets, including checks and balances between assignment, storage, search, quality, reliability, completeness, and latency. Secure Sensor Networks: - Continue all efforts from FY 2008 less those noted as completed above. - Complete the development of a prototype for an information sharing infrastructure that maintains data integrity and confidentiality for enclaves of networked workstations running Commercial Off the Shelf (COTS) operating systems and applications.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete development of technology for improved steganography and watermarking. - Initiate development of improved separation technology for shared-hardware host execution environments to increase information security. *FY 2010 Plans:* - Automated Intelligence Tools: - Continue all efforts from FY 2009 less those noted as completed above. - Complete development of interactive image/video-based surveillance systems for perimeter protection, and port protection. - Initiate development techniques for image coding based on shapes and regions and their temporal evolution to facilitate image analysis as well as to enable efficient image transmission and restoration. Develop methods for efficient search of large image and video databases to facilitate automated, real-time image/video registration for surveillance applications, threat detection, and target geo-location. - Initiate development of mathematically rigorous techniques and algorithms for automated understanding of surveillance imagery, including background modeling to assist image context interpretation and multi-sensor characterization of complex scenes. Battlespace Sensor and Intelligence Integration: - Continue all efforts from FY 2009 less those noted as completed above. - Initiate development of tools and processes including higher level statistical methods, game theory, first order logic form, Bayesian networks, and fusion algorithms, to model enemy behavior and provide threat assessment, represent complex data patterns, and model the structure of context to improve the data fusion process. - Initiate demonstrations of ontologies in a maritime environment using an experimental testbed or limited technology experiments to validate new approaches to inference and higher-level fusion capabilities. - Initiate development of algorithms to generalize the characterization of ontologies and to integrate them, including machine processing compatibility to effectively link methods for visualization and human processing (UML methods) with machine and information exchange and processing (XML methods). Automated Reasoning Methods and Models for Situational Analysis:				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue all efforts from FY 2009 less those noted as completed above. - Initiate development of techniques to uncover trends, links, hidden models, and relationships of behavior/activity that will lead to inferring intent and developing course-of-action (COA) alternatives. - Initiate development of robust reasoning methods supporting automated situational understanding for maritime domain awareness under time-critical constraints and uncertainty. - Initiate development of methods of grouping situations to categorize algorithms for reuse under a variety of conditions, including Naval situation recognition and categorization (used to group similar situational types); situation characterization to define threshold qualifications to “bin” situations within categories (abductive development as a threshold process); situation projection to develop techniques to characterize features necessary to classify a situation – counterfactuals and inductive development. Automated Decision Tools: - Continue all efforts from FY 2009 less those noted as completed above. - Complete the development of methods for selecting sensors and platforms for search and surveillance operations in a theater, allocating the selected sensors and platforms to specific missions, operating the allocated sensors during a mission, and fusing the information from the sensors and other sources. Secure Sensor Networks: - Continue all efforts from FY 2009 less those noted as completed above. - Initiate development of algorithms, secure protocols, architectures, software tools, languages, certification technologies, standards, guidelines to assure safe, secure, policy-compliant, interoperable systems for information transfer.					
HUMAN FACTORS AND ORGANIZATIONAL DESIGN The overarching objective of this activity is the achievement of FORCEnet and Sea Power 21 goals by developing human factors principles and cognitive models for human centric design, decision support systems for collaborative decision making, and adaptive command and control structures. The CNO’s new Maritime Strategy and the Commander Fleet Forces Command complementary plan to revise organization of Maritime Operations Centers (MOC) place high priority on the aforementioned FORCEnet and Sea Power 21 goals. Specific objectives focus on improving small team, platform, task force, and battle group		7.011	4.978	6.597	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
operations by developing advanced human factors technologies for incorporation into operational systems. The goals and payoffs are to enhance human performance effectiveness; improve the timeliness and quality of decision making; develop strategies to mitigate high workload and ambiguity; reduce manning; improve situational awareness and speed of command through a deeper understanding of human capabilities and limitations; and improvement of team decision making in ad-hoc, complex problem solving scenarios. The current specific objectives are: a) Human Computer Interaction/Visualization: Develop an understanding of the limitations of human perceptual and attentional systems in relation to maximizing user performance when interacting with complex Naval displays. A combination of computational cognitive modeling and psychological studies are employed to determine the capacity limitations on human performance that will undoubtedly have impact in reduced manning requirements, including information-rich weapons platforms. Develop technology for improving human interaction with autonomous systems and for improving virtual reality systems for training purposes. b) Collaboration and Knowledge Interoperability: Develop an understanding of the high-level cognitive processes underlying team knowledge processing, decision making and collaboration in order to improve team performance in the autonomous, agile, quick-response combat team of the future. Develop cognitive science-based tools, models, computational methods, and human-agent interfaces to enhance team collaboration effectiveness and team performance in complex problem solving teams. Specific objectives include application of discourse analysis methods and other process metrics to assess team performance. A conceptual model of team collaboration will be constructed and computational relationships among processes and team performance will be developed. Findings will be validated and demonstrated in operationally oriented testbeds by addressing issues including: rapid team analysis of large volume, uncertain data; knowledge interoperability in coalition ops; measures of team situational awareness; accelerated team synchronization; improved heterogeneous team performance; team collaboration performance metrics; cultural/language/experience-free representation and transfer of meaning. c) Organizational Design and Decision Support Systems: Develop quantitative executable models, task graphs and optimization algorithms for the organizational design of Maritime Operations Centers (MOC)				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
consistent with the Navy's New Maritime Strategy. Investigate through modeling and simulation human competency requirements for staffing MOC. Develop quantitative formalisms for monitoring and assessing the completeness, consistency and accuracy of rules of engagement (ROE). d) Social Network Analysis: Develop computational models and algorithms for the analysis of terrorist threats and counter-measures and strategies against terrorist threats. Develop new computational algorithms for the discovery of missing and hidden nodes in complex graphs applicable to the problem of understanding hidden information in terror networks. Develop new approaches to calculation of network completeness. Develop computational approaches to the study of factionalism in social movements using Islamist movements as exemplar data collectivities. The decrease from FY 2008 to FY 2009 reflects the completion of development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays, research on tools to assist in the management of task interruptions. The increase from FY 2009 to FY 2010 reflects new program research to support MOC and additional social and cultural modeling. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2008 Accomplishments:* Human Computer Interaction/Visualization: - Continued application of cognitive architecture modeling to the design of interface analysis tools. - Completed development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays. - Completed research on tools to assist in the management of task interruptions. - Completed 3D audio experiments in the context of Common Enterprise Display System (CEDS) to evaluate cognitive models of 3D audio perception.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated research on the application of information architectures (DOD Architectures Framework), executable models (Petri Nets) and cognitive models to the systematic design of Human-Computer Integration. - Initiated effort to develop tools for more automated, cost-efficient modeling of human system interaction. - Initiated methods to introduce key cognitive abilities to autonomous vehicles that will enable warfighters and vehicles to work together more collaboratively. Collaboration and Knowledge Interoperability: - Continued evaluation of Latent Semantic Analysis (LSA) of operator communications as an effective metric of shared situational awareness in unmanned aerial vehicle control teams. - Continued demonstration of Electronic Card Wall (EWALL) (a computational human cognitive processing system) for representation and transfer of meaning among heterogeneous and distributed team members engaged in complex problem solving. - Continued developing jointly with the Naval Air Systems Command, a FORCEnet-based test bed to identify and evaluate the cognitive processes to be employed to optimize collaborative decision-making in a geographically distributed and time-delayed situation. - Continued effort to improve response speed of the LSA tool to a near-interactive level and incorporate into a fleet experiment. Collected and evaluated data to validate improved speed and effectiveness of developing situational awareness. - Continued effort to incorporate the EWALL prototype into a simulation of the Tactical Operations Center of the Special Operations Forces and collected performance data to validate effectiveness. - Continued Sea Basing research on rehearsal for Expeditionary Strike Groups in the conduct of Maritime Interdiction Operations (MIO) and developed reach-back capability for computationally intense analysis for evaluating courses of action. - Initiated development of metrics to identify and measure the contribution to team performance of the cognitive processes underlying ad-hoc team decision making. - Initiated effort to improve the model of ad-hoc team decision making by including collaborative agent-based contribution to team performance. Organizational Design and Decision Support Systems:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued model-based simulations and experiments to investigate the effectiveness of hierarchical organizational structures in network-centric operational environments in order to evaluate the implementation of FORCEnet concepts. - Continued deployment of models for Effects-Based Operations (EBO) aboard naval vessels to support Expeditionary Group One to conduct kinetic and non-kinetic tactical operations in a measured manner. - Continued jointly with the Air Force applied research on the integration of Information Operations in Air Control Centers. - Continued applied research on command and control adaptive architectures for Expeditionary Strike Groups working with OPNAV and Expeditionary Strike Group ONE, San Diego. - Initiated research on adaptive command and control architectures in support of the Navy's new Maritime Strategy. Social Network Analysis: - Continued development of new threat scenarios incorporating Joint Force Maritime Component Commander operations, counter-insurgency and humanitarian operations with the staff of the Naval War College. These new threat scenarios will provide the basis for Limited Objective Experiments in the Innovation Laboratory at the Naval War College. - Continued development of Dynamic Network analysis (a terrorist network analysis tool) in operational command setting at U.S. Pacific Command. - Continued the improvement of terror network analysis decision tools for combatant command use and military planning, including testing of tools, development of metrics, and validation. - Continued the development of advanced computational models capable of analyzing multi-dimensional networks of thousands of nodes. Current capabilities enable the analysis of networks consisting of hundred of nodes. - Continued the development of computational models of influence that incorporate the social structure, values and cultural processes of urban non-western communities for achieving post-conflict stabilization. - Continued the development of social network models to model the human element in maritime domain awareness.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated research on advanced computational models to incorporate additional capabilities in the analysis of terror networks and on various types of flow in these networks (such as the flow of expertise, resources). - Initiated effort to improve social network models to analyze merchant marine traffic. *FY 2009 Plans:* Human Computer Interaction/Visualization: - Continue all efforts of FY 2008 less those noted as completed above. Collaboration and Knowledge Interoperability: - Continue all efforts of FY 2008 less those noted as completed above. - Initiate development of a computational model of subjective reasoning for course of action selection activity in distributed, asynchronous teams. - Initiate test and validation of a cognitive processes model of team collaboration in a Maritime Interdiction Operations domain. - Initiate integration of high-level planning and computational cognition with low-level to enhance situational awareness via swarm-based sensor platforms. Organizational Design and Decision Support Systems: - Continue all efforts of FY 2008 less those noted as completed above. - Initiate research on quantitative formalisms for developing and assessing the completeness, consistency and accuracy of rules of engagement (ROEs). - Initiate research on executable models and optimization algorithms for adaptive command structures that are congruent with mission requirements to support the design of Maritime Headquarters with Maritime Operations Centers (MHQ/MOC) organizations. - Initiate research on models to support the design of scalable joint and coalition Maritime Operations Centers that allocate responsibilities to elements afloat and ashore. Social Network Analysis: - Continue all efforts of FY 2008 less those noted as completed above.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiate human cultural and social modeling to improve warfighting, civilian military operations and humanitarian operations in non-Western environments. *FY 2010 Plans:* Human Computer Interaction/Visualization: - Continue all efforts of FY 2009. - Initiate development of a testbed for validating cognitive models of operator performance in cross-modal (audio/visual) task environments. Collaboration and Knowledge Interoperability: - Continue all efforts of FY 2009. - Initiate research on the use of metaphors and temporal mental models to improve representation and transfer of meaning in ad-hoc, complex team problem solving with the objective of enhancing team collaboration effectiveness and team performance. - Initiate validation of a conceptual model of macrocognition in teams. Scenario-based experimentation will define the presence, persistence and relevance of individual and team cognitive processes and relationships among those processes. Deliverable will be a computational understanding of how teams collaborate to reach consensus. Organizational Design and Decision Support Systems: - Continue all efforts of FY 2009. - Initiate, in cooperation with the Air Force, the capability to examine human competency requirement in offensive and defensive cyber operations and the effects of courses of action at the tactical and operational level. The research would be conducted using DOD and academic laboratories capable of high fidelity mission simulation and precise measurements of independent and dependent measures. Social Network Analysis: - Continue all efforts of FY 2009.				
KNOWLEDGE SUPERIORITY AND ASSURANCE	29.468	18.485	25.755	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
This activity is devoted to midterm technology development in close concert with programs of record. The products of these efforts are expected to transition at the end of their schedule into the associated program of record. The Future Naval Enabling Capabilities in this activity span across the Information Infrastructure, Applications/Tools/Decision Aids, Command and Control, Apertures and Radios, and Tactical Networks and Network Control/Management technology areas. Technologies being developed will integrate sensors, networks, decision aids, weapons and supporting systems into a highly adaptive, human-centric, comprehensive maritime system. This system will operate from the sea bed to space in a Service Oriented Architecture that can be used in a Joint Environment. The current specific objectives are: a) Combat ID Information Management of Coordinated Electronic Surveillance - Develop software algorithms and techniques for the purpose of dynamically re-tasking organic sensors in conjunction with fused intelligence products to support Command Control and Combat Systems. Efforts will include developed capability for automated integration of multi-intelligence surveillance & reconnaissance of red, white, and blue force locations for Combat Identification by providing software integrated into Navy and Marine Corps Command Control and Combat Systems. b) Automated Control of Large Sensor Networks - Develop smart tactical sensors/platforms and software algorithms for automated and mission specific tactical sensor fields capable of fulfilling specific mission objectives with smart sensors that forward knowledge vice raw data. c) OCO Focused Tactical Persistent Surveillance - Develop agile and enhance tactical sensors for a netted, organically controlled, adaptive sensor field that is capable of detecting and classifying features relevant to the global war on terror to include organic sensors for small tactical expeditionary units, capable of supporting the dynamic character of modern operations from the highly mobile to the long-term. d) Globally Netted Joint/Coalition Force Maritime Component Commander - Develop automated tools and software to capture and share information for ‘globally-networked, theater-focused’ maritime capabilities that will enhance Joint Task Force (JTF) and COCOMs’ ability to execute their intentions.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
e) Dynamic Tactical Communications Networks - Develop dynamically adaptive automated software algorithms, protocols, and network management techniques that provide a self-organizing networking capability. This capability will adapt to available links of opportunity at lower echelons and assure priority movement of critical data intra-network and through reachback gateway networks that interface with the Global Information Grid (GIG). f) Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC) - Develop software for command control and combat systems that will provide the maritime commander agile and responsive control and management of tactical Antisubmarine Warfare (ASW) and interactions in a net centric enterprise environment. Focus will address classified ASW requirements for command and control at the tactical level. g) High-bandwidth Free-space Lasercomm - Develop, integrate and demonstrate free-space optical terminals and retro-reflector optics that are designed to provide an affordable, reliable and high-bandwidth Free-Space Laser Communications (Lasercomm) capability which is adaptive and agile in mitigating a wide range of atmospheric and maritime turbulence, precipitation and obscuration conditions. This capability will enable surface and airborne platforms to exchange very high bandwidth information in Navy Tactical Networks, even with limited SATCOM or RF spectrum access. h) Actionable Intelligence Enabled by Persistent Surveillance - Develop analysis tools and software that will provide accurate threat detection by exposing the enemy's vulnerabilities, unmasking their latent networks, discovering their tactics, techniques, procedures and exploiting in new ways the vast amount of sensor data available today against an irregular threat. Also develop the following: An electro-optical, infrared and laser Intelligence, Surveillance, and Reconnaissance Targeting (ISRT) optics technology, capable of wide Field of View/Field of Range (FOV/FOR) at variable resolution & pointing direction, for installation in mobile platforms without gimbals; a light weight, low cost sensor suite and autonomy algorithms to enable detection and avoidance of all classes of aircraft or Unmanned Aerial Vehicles (UAV).				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
i) Real-Time Long Range Air Defense Combat ID in Support of Early Engagements - Develop algorithms and open architecture compatible software that will provide real-time long range air defense combat ID in support of early engagements. Specific efforts support Naval Integrated Fire Control - Counter Air (NIFC-CA) capability by enabling fleet Theater Missile Air Defense (TAMD) units to use real-time and non-real time sensor and ISR data to rapidly build ID on long-range contacts. The decrease from FY 2008 to FY 2009 is due to completion of FNC efforts to develop object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment, and the development of technologies for smart tactical sensors, platforms, and algorithms in an urban/cluttered environment. The balance of the reduction reflects a reduced level of investment in ongoing efforts to fund higher priority requirements. The increase from FY 2009 to FY 2010 is due to the initiation of new FNC efforts to develop tools and software that will increase the commander's ability to predict threats and support weapons allocation. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2008 Accomplishments:* Combat ID Information Management of Coordinated Electronic Surveillance: - Continued the Electronic Warfare Integrated System for Small Platforms (EWISSP) effort by exploration and refinement of the subsystem interface software that will operate via Versa Module Eurocard (VME)-64 and Recommend Standard (RS)-422 buses. - Continued Actionable Information from Multiple Intel Sources in a Global Information Grid Enterprise Services (GIG-ES) Environment. Provides automated integration of multi-INT surveillance and reconnaissance of red, white, and blue force locations for Combat ID by providing software integrated into Navy and Marine Corps Command Control & Combat Systems; order of magnitude less false recognition; and identification of significant military entities consistent with sensor capabilities. - Continued developing and testing airborne and shipboard battle manager platforms for UAVs operating from Littoral Combat Ships. Continued developing and began testing an open architecture airborne control station that can be used onboard a P-3 type aircraft for the control of multiple UAVs.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued the all-source track and identity fusion effort integrating a broad range of intelligence product information including: Kinematic Radar Reports, Organic and UAV imagery, electronic and communications emissions and human spot reports for tactical and organic sensors to be augmented with national sensors. Automated Control of Large Sensor Networks: - Continued design of tools enabling mission-specific tactical sensor fields for at least two separate mission areas. - Continued design of tactical distributed data analysis and automated indications and warnings for 50% of tactical data. - Continued design of automated tactical platform and sensor planning and management sufficient for one operator to control multiple sensors. - Continued investigation of human to tactical sensor field interface to enable the user to locate relevant knowledge within 3 minutes. - Continued development of automated and mission aware large tactical sensor management engines and irregular threat and tactical sensor ontologies. - Continued development of the agents and other analysis applications enabling a fully netted tactical battlespace. OCO Focused Tactical Persistent Surveillance: - Completed investigation of smart tactical sensors, platforms, and algorithms in an urban/cluttered environment for at least 2 sensing modalities. Globally Netted Joint/Coalition Force Maritime Component Commander: - Completed development of object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment. *FY 2009 Plans:* Combat ID Information Management of Coordinated Electronic Surveillance: - Continue all efforts of FY 2008.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Automated Control of Large Sensor Networks: - Continue all efforts of FY 2008. Globally Netted Joint/Coalition Force Maritime Component Commander: - Initiate effort to develop and apply emerging technologies that support delivery of Navy-approved FNC enabling capabilities structured to close operational capability gaps that involve the common picture. - Initiate packaging of emerging common picture technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period. - Initiate efforts for the mature common picture technologies that support naval requirements identified within the FORCEnet naval capability pillar. Dynamic Tactical Communications Networks: - Initiate effort to develop and apply emerging technologies that support self organizing networking and assured communications exchange in tactical communications networks. Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC): - Initiate effort to develop new, and leverage emerging, technologies that support dynamic and response management and control of net-centric enterprise theater and tactical ASW operations. This includes automation support for synchronized planning of resources and multi-mission execution, and access and shared awareness of data activities and status among Maritime Operation Centers and tactical forces in a tactical, netted service-oriented architecture (SOA) environment. *FY 2010 Plans:* Combat ID Information Management of Coordinated Electronic Surveillance: - Continue all efforts of FY 2009. - Initiate demonstrations of the adaptation of fusion and resource management capabilities directly into Distributed Information Operations-Service (DIO-S). Automated Control of Large Sensor Networks:				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue all efforts of FY 2009. - Initiate demonstrations of mission-aware planning tools that allow large sensor networks to support tactical operations. OCO Focused Tactical Persistent Surveillance: - Initiate development of high information tactical agile sensors, including tactical RF sensors, sensors to sense the state of a person and smart tactical imagers and acoustic sensors. Globally Netted Joint/Coalition Force Maritime Component Commander: - Continue all efforts of FY 2009. - Initiate development of fusion algorithms and methods that support building and maintaining large distributed databases; implementing GIG-compliant data strategies; mediating and integrating across heterogeneous databases; accessing and discovering authenticated users and brokering agents; and identifying ambiguities or inconsistencies for additional sensing and processing. Dynamic Tactical Communications Networks: - Continue all efforts of FY 2009. - Initiate development of distributed-and dynamic policy based network management, secure mobility management solutions, and network service discovery mechanisms. - Initiate development of robust and bandwidth efficient group communication protocols for the tactical environment, including disruption tolerance and inter-domain (security and routing) protocols for fully-connected domains. Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC): - Continue all efforts of FY 2009. - Initiate development of tools and algorithms that support automated data access, shared awareness, and automated synchronized planning, coordination and execution of network enterprise resources among tactical units with limited/degraded communications. High-bandwidth Free-space Lasercomm:				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate development of mitigation techniques for laser beam propagation through atmospheric turbulence and aerosol obscuration. - Initiate development of and demonstrate technologies that support high bandwidth laser communications, including fast acquisition and fine beam steering/tracking algorithms; wide-area avalanche photo-diode receive array techniques; and high bandwidth wide field-of-view retro-reflector optics. Actionable Intelligence Enabled by Persistent Surveillance: - Initiate development of advanced analysis tools that are relevant to the information needs of tactical warfighters engaged against irregular actors. - Initiate development of a multi-modal tactical wide area surveillance payload and sensors relevant to tier-2 UAVs that can detect other airborne platforms.					
MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION This activity addresses theater air and missile defense (TAMD), and responds to warfighter needs for rapid, high confidence Combat Identification (CID) of air and missile threats at long range using real time and non-real time threat attributes and intelligence information. It supports the Sea Shield Pillar Enabling Capability of Real Time Long Range Air Defense CID in Support of Early Engagements and related CID Science & Technology to be worked under the FORCEnet FNC. The increase between FY 2008 and FY 2009 is to support completion of research for networked sensors. The decrease between FY 2009 and 2010 reflects the completion of the CID effort. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. *FY 2008 Accomplishments:* - Continued development of a robust test environment to elucidate the design principles of human and sensor network interactions.		1.893	3.183	1.005	

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APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602235N COMMON PICTURE APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continued effort to improve the resolution of the High Frequency Relocatable Over-the-Horizon Radar (HF-ROTHR) more than two orders of magnitude using time-reversal methods. *FY 2009 Plans:* - Continue all efforts of FY 2008. - Complete development of a robust test environment to elucidate the design principles of human and sensor network interactions. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above.					
TACTICAL SPACE EXPLOITATION The Tactical Space Exploitation initiative explores the application of new space craft technologies on small, light-weight and low-cost satellites to enhance naval warfighting capabilities; taking advantage of the global access, revisit and connectivity provided by orbital platforms. Initial efforts will be aimed at developing integrated signals electronics packages to test new concepts for global ship tracking and two-way data exfiltration using next-generation Internet Protocol (IP) technology from an array of sea-based and land-based sensors. Advanced multispectral/hyperspectral electro-optical sensors will be developed to demonstrate new warfighting constructs and communications payload technology deployed on satellites to demonstrate augmented mobile satcom capabilities over a theater. Development of payload and bus technologies that will serve as building blocks for future responsive space systems: payloads, bus technologies and, significant space robotic technologies that address on-orbit inspection, servicing, repair and assembly, and mission-life extension. The decrease between FY 2008 and FY 2009 is the result of investments in this activity being curtailed in response to completion of the development of a communications satellite payload to provide augmented mobile satcom over a theater from high altitude earth orbit with payload launch in late FY 2008. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.		22.699	16.719	16.048	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2008 Accomplishments: - Continued development of integration plans, algorithms, and satellite concept of operations to demonstrate the integrated signals payload as a secondary payload on a FY 2008 small satellite launch. - Continued development of small multifunctional integrated signals electronics systems for ship tracking from space and two-way data exfiltration from distributed global sensors. - Continued development of a satellite-borne electro-optical sensor system for FY 2009 launch to the International Space Station to test new techniques for surveillance of environments and targets of naval interest for anti-submarine warfare and mine warfare. - Continued program to use chemical release from satellites launched into selected low-Earth orbits to de-populate intense trapped electrons in radiation belts following a low-altitude nuclear explosion in space. - Completed development and launch of communications satellite payload to provide augmented mobile satcom over a theater from high altitude earth orbit. - Initiated the development of a highly capable self-inspection vehicle for spacecraft with large complex deployables. - Initiated the development of a preliminary design for electrodynamic propulsion technology demonstration spacecraft. *FY 2009 Plans:* - Continue all efforts of FY 2008 less those noted as completed above. - Complete and launch maritime hyperspectral payload on TacSat or Space Test Program (STP) satellite. Develop improved maritime hyperspectral payload for flight on the International Space Station through STP. Complete analysis of TacSat 3 data. - Initiate effort to develop technologies using autonomous bi-dexterous manipulation for close-proximity operations in space. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above. - Complete Comm-X payload and launch it aboard TACSAT 4 satellite.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
PE 0204152N/E-2 Squadrons									Continuing	Continuing
PE 0205601N/HARM Improvement									Continuing	Continuing
PE 0206313M/Marine Corps Communications Systems									Continuing	Continuing
PE 0601153N/Defense Research Sciences									Continuing	Continuing
PE 0602114N/Power Projection Applied Research									Continuing	Continuing
PE 0602123N/Force Protection Applied Research									Continuing	Continuing
PE 0602131M/Marine Corps Landing Force Technology									Continuing	Continuing
PE 0602204F/Aerospace Sensors									Continuing	Continuing
PE 0602236N/Warfighter Sustainment Applied Research									Continuing	Continuing
PE 0602271N/ Electromagnetic Systems Applied Research									Continuing	Continuing

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APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602235N COMMON PICTURE APPLIED RESEARCH	PROJECT NUMBER 0000	
PE 0602702F/ Command Control and Communications			
PE 0602782A/Command, Control, Communications Technology		Continuing	Continuing
PE 0603114N/Power Projection Advanced Technology		Continuing	Continuing
PE 0603123N/Force Protection Advanced Technology		Continuing	Continuing
PE 0603235N/Common Picture Advanced Technology		Continuing	Continuing
PE 0603236N/Warfighter Sustainment Advanced Technology		Continuing	Continuing
PE 0603271N/ Electromagnetic Systems Advanced Technology		Continuing	Continuing
PE 0603609N/ Conventional Munitions		Continuing	Continuing
PE 0603640M/USMC Advanced Technology Demonstration (ATD)		Continuing	Continuing
PE 0603658N/Cooperative Engagement		Continuing	Continuing
PE 0604307N/Surface Combatant Combat System Engineering		Continuing	Continuing

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PE 0604518N/Combat
Information Center
Conversion

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Performance metrics are discussed within the R2a.