Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Navy										DATE: February 2012	
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 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**Cost To Complete**	**Total Cost**
Total Program Element	68.155	65.184	41.696	-	41.696	37.889	39.780	40.649	40.307	Continuing	Continuing
0000: *Common Picture Applied Research*	68.155	65.184	41.696	-	41.696	37.889	39.780	40.649	40.307	Continuing	Continuing

Note

FY 2013 funding associated with Future Naval Capability (FNC) efforts are transferring to a new Program Element titled Future Naval Capabilities Applied Research (PE 0602750N). This is to enhance the visibility of the FNC Program by providing an easily navigable overview of all 6.2 FNC investments in a single location.

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 (Sep 2011). 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 investments in the following Enabling Capabilities (ECs): Combat Identification (ID) Information Management of Coordinated Electronic Surveillance, Automated Control of Large Sensor Networks, OCO 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, Pro-Active Computer Network Defense and Information Assurance, Fast Magic, Naval Research Laboratory (NRL) Space; Advanced Tactical Data Link; and Autonomous Tactical Persistent Surveillance. 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.

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B. Program Change Summary ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**
Previous President's Budget	70.168	65.448	62.408	-	62.408
Current President's Budget	68.155	65.184	41.696	-	41.696
Total Adjustments	-2.013	-0.264	-20.712	-	-20.712
• Congressional General Reductions	-	-0.264			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.078	-			
• SBIR/STTR Transfer	-1.477	-			
• Program Adjustments	-	-	-21.126	-	-21.126
• Rate/Misc Adjustments	-	-	0.414	-	0.414
• Congressional General Reductions Adjustments	-0.458	-	-	-	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

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COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
0000: *Common Picture Applied Research*	68.155	65.184	41.696	-	41.696	37.889	39.780	40.649	40.307	Continuing	Continuing

A. Mission Description and Budget Item Justification

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: COMMUNICATION AND NETWORKS	10.237	7.370	7.330
Description: 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013

to fully realize net-centric warfare, bridging the Global Information Grid (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 antijam 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.

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 selforganizing 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 decrease from FY 2011 to FY 2012 is associated with reduced efforts in Intelligence, Surveillance, and Reconnaissance Targeting (ISRT)- Electro-Optic/Infrared (EO/IR), EW Attack, and Communication and Networks.

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

FY 2011 Accomplishments:

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Radios and Apertures: - Continued metamaterials based dish antennas development for Ka-Ku band satellite communications (SATCOM). - Continued development of low intercept and low probability of Detection (LPD), jam resistant communications/networks for distributed nodes. - Continued blue-green fiber laser technology development for space-based submarine communications. - Continued development and demonstrate electrically small antennas at Very Low Frequency/High Frequency (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. - Continued design and development of low observable jam resistant waveform, including directionalization, for advanced tactical data links. - Continued design and development of electronic protection for HF communications. - Completed development of underwater Extremely Low Frequency (ELF) antenna and RF technology for submarine comms at speed and depth. - Developed structurally integrated HF antennas - Developed integrated metamaterial antennas for ship and ground platforms. - Demonstrated high peak power short pulse operation of fiber lasers in blue-green region. - Developed optical wavefront modulation techniques and optical phased array beam steering methods for terrestrial EO/IR Lasercomm. - Developed new architecture and modes of operation for advanced tactical data link operation in both contested and anti-access regions. Tactical Networking and Network Control/Management: - Continued 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. - Continued development of topology control, discovery mechanisms and directional networking for free space optical links. - Continued design and development of cognitive netops for tactical communications. - Developed social network analysis algorithms for protecting wireless networks. - Developed agent based communications, control and distributed authentication techniques in dynamic MANET networks. - Developed cognitive networking, cross-layer optimization protocols for light SOA for tactical networks. - Developed effort to improve secure voice by developing secure voice technology that can interoperate between tactical and strategic networks.			
FY 2012 Plans: Radios and Apertures:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Continue all efforts of FY2011 less those noted as completed. - Complete metamaterials based dish antennas development for Ka-Ku band satellite communications (SATCOM). - Developed a novel fiber technology that enables tunable, energy-scalable emissions at a user-defined/desired wavelength, particularly in the blue-green spectral range. - Researched and developed the use of novel metamaterials and metastructures that enable conformal antenna designs with ultra-wideband performance. - Developed program for a novel blade antenna payload for wideband Ku/UHF communications that is light weight, has lower power consumption, and is very low cost. Tactical Networking and Network Control/Management: - Continue all efforts of FY2011 less those noted as completed. - Complete development of agent based communications, control and distributed authentication techniques in dynamic MANET networks. - Developed program that leverages topology discovery, content modeling, and resource scheduling to support content management functions at the Tactical Edge. - Research and develop managing and controlling functions within a protected routing core at the Tactical Edge.			
FY 2013 Plans: Radios and Apertures: - Continue all efforts of FY2012 less those noted as complete. - Complete development and demonstrate electrically small antennas at Very Low Frequency/High Frequency (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. - Develop technologies to improve spectrum co-existence of military waveforms with commercial communications (e.g., overlay/ underlay techniques, interference cancellation, machine learning and reasoning algorithms for distributed spectral awareness/ management, etc.). Tactical Networking and Network Control/Management: - Continue all efforts of FY2012 less those noted as complete. - Complete effort to improve secure voice by developing secure voice technology that can interoperate between tactical and strategic networks. - Complete 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Develop dynamic routing mechanisms that focus on robust data delivery -- in near real time -- under harsh networking conditions (i.e., intermittent connectivity, limited throughput, etc.).			
Title: APPLIED INFORMATION SCIENCES FOR DECISION MAKING	15.267	14.945	10.830
Description: 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. Effective FY 2013 this activity title has been changed from Computational Framework and Methods for Rapid Accurate Decision Making to Applied Information Sciences Decision Making in order to completely capture the work being performed. 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 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013

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 decrease from FY 2012 to FY 2013 is a result of the realignment of funds for Radar and Surveillance efforts to the Multi-source Integration and Combat Identification R2 Activitiy.

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

FY 2011 Accomplishments:
Automated Intelligence Tools:

- Completed the demonstration and conducted image registration error analysis for the multi-resolution and multi-scale image processing effort.
- Completed development of semi-supervised detection algorithms for multi-sensor imagery, video and human intelligence that will enable self deploying sensor networks.
- Completed 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, realtime image/video registration for surveillance applications, threat detection, and target geo-location.
- Completed 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.
- Developed methods for integration of low-level image processing and high-level knowledge for simultaneous image segmentation and object recognition, and visual reasoning for image understanding.
- Developed 3D image processing for object recognition and meaningful change detection.
- Developed modular, interactive, intelligent video-based surveillance systems.
- Developed and demonstrated revolutionary hyperspectral imaging spectrometer algorithms and system.
- Developed a vision-based system for tactical unmanned aerial vehicle to navigate paths without requiring maps or GPS.

Battlespace Sensor and Intelligence Integration:
- Completed the development and testing of the Joint Integrated Fires Control effort.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Completed demonstration of a trusted data store which maintains data pedigree and detects anomalies in a limited objective experiment. - Completed development of an interface between the Level 1 and Level 2/3 data fusion processes across federated service oriented architectures. - Completed 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. - Completed 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 software and algorithms for integrating the functions of target acquisition, tracking, data computation, and engagement control across multiple platforms for engaging multiple threats. - Completed the investigation of service oriented methods to automatically retrieve relevant information for a community of interest. - Completed 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. - Completed 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. - Completed 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. - Completed 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). - Developed algorithms and tools for information representation of unstructured data and structured data in a way that shared concepts/relationships in disparate data sets can be automatically compared, matched, or associated and in a way that can facilitate and improve information fusion. - Developed algorithms and tools for information fusion of heterogeneous data for classification and reconstruction based on highlevel features inherent in each data source with the goal to form a more complete picture of battlespace environment. - Developed algorithms and tools for discovering and extracting higher-level features -- objects, events, patterns, intents, relations, anomalies -- from various data types in support of future asymmetric warfare. Automated Reasoning Methods and Models for Situational Analysis:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Completed 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. - Completed development of methods for automated generation of courses of action, including techniques for automated planning and reasoning in uncertain environments. - Completed 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. - Completed 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. - Completed development of robust reasoning methods supporting automated situational understanding for maritime domain awareness under time-critical constraints and uncertainty. - Completed 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: - Continued 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. - Completed the 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. - Developed optimization-based decision aids for resource allocation such as those required for mission planning at the strategic, operational, and tactical level. Secure Sensor Networks: - Completed development of technology to improve reliability of systems to survive Information Warfare attacks. - Completed development of improved separation technology for shared-hardware host execution environments to increase information security. - Completed development of algorithms, secure protocols, architectures, software tools, languages, certification technologies, standards, guidelines to assure safe, secure, policy-compliant, interoperable systems for information transfer.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Developed anti-tamper methods that are capable of lengthy operation in unattended and un- powered environments, have very high probability of tamper detection and very low probability of false alarm, and remain undetected in the host system. ***FY 2012 Plans:*** Automated Intelligence Tools: - Continue all efforts from FY 2011 less those noted as completed above. - Develop methods for building sophisticated visual knowledge bases, development of methods for visual reasoning and integrating them in image/video understanding, and development of methods for image description. Battle-space Sensor and Intelligence Integration: - Continue all efforts from FY 2011 less those noted as completed above. Automated Reasoning Methods and Models for Situational Analysis: - Develop mission-focused autonomy and reasoning methods; expand autonomy from simple platform kinematics to include all-source information exploitation and surrounding cultural and social influences. Automated Decision Tools: -Continue all efforts from FY 2011 less those noted as completed above. Secure Sensor Networks: - Continue all efforts from FY 2011 less those noted as completed above. - Develop automated tools that identify and mitigate potential software vulnerabilities, such as tools that analyze code as it is being written, vulnerability-aware compilers that automatically enhance code security, and techniques for enhancing the client-side security of web applications. ***FY 2013 Plans:*** Automated Intelligence Tools: - Continue all efforts from FY 2012. - Complete the development and demonstration of revolutionary hyperspectral imaging spectrometer algorithms and system. Battle-space Sensor and Intelligence Integration: - Continue all efforts from FY 2012. Automated Reasoning Methods and Models for Situational Analysis: - Continue all efforts from FY 2012.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Automated Decision Tools: -Continue all efforts from FY 2012. Secure Sensor Networks: - Continue all efforts from FY 2012.			
Title: HUMAN FACTORS AND ORGANIZATIONAL DESIGN	6.107	6.439	6.315
Description: 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 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013

team situational awareness; accelerated team synchronization; improved heterogeneous team performance; team collaboration performance metrics; cultural/language/experience-free representationand transfer of meaning.

c) Organizational Design and Decision Support Systems: Develop quantitative executable models, task graphs and optimization algorithms for the organizational design of MOC 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 following are non-inclusive examples of accomplishments and plans for projects funded in this activity.

FY 2011 Accomplishments:

Human Computer Interaction/Visualization:
- Continued application of cognitive architecture modeling to the design of interface analysis tools.
- Continued 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.
- Continued effort to develop tools for more automated, cost-efficient modeling of human system interaction.
- Continued development of a testbed for validating cognitive models of operator performance in crossmodal (audio/visual) task environments.
- Continued methods to introduce key cognitive abilities to autonomous vehicles that will enable warfighters and vehicles to work together more collaboratively.
- Developed the multitasking and metacognitive components of the Tactical Action Officer (TAO) model, especially as they apply to dual-tasks involving "chat" style instant-messaging interleaved with other watchstanding duties.
- Developed spatialized 3D-audio displays to mitigate cognitive load during the performance of dual-tasks.
- Investigated human attentional limitations in understanding sped-up and serialized speech over multiple radio channels.
- Developed cognitive-model-based predictors of operator error in procedural tasks.
- Developed cognitive models of the TAO to be utilized within a virtual Combat Information Center (CIC) simulated environment.
- Investigated auditory attentional effects on watchstanding activities, especially in the context of monitoring multiple radio channels. Results will be used to provide recommendations for new communications protocols.

Exhibit R-2A, RDT&E Project Justification: PB 2013 Navy		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
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 decisionmaking 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. - Continued development of metrics to identify and measure the contribution to team performance of the cognitive processes underlying ad-hoc team decision making. - Continued effort to improve the model of ad-hoc team decision making by including collaborative agent-based contribution to team Performance. - Continued development of a computational model of subjective reasoning for course of action selection activity in distributed, asynchronous teams. - Continued test and validation of a cognitive processes model of team collaboration in a Maritime Interdiction Operations domain. - Continued integration of high-level planning and computational cognition with low-level to enhance situational awareness via swarm-based sensor platforms. - Continued 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. - Continued 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. - Developed a performance measurement testbed for assessing the contribution of highlevel cognitive (macrocognitive) processes to collaboration effectiveness and team performance in special operations intelligence analysis. - Validated computational team collaboration performance metrics for quick response teams such as maritime interdiction operations and non-combatant evacuation operations.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Organizational Design and Decision Support Systems: - 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. - Continued research on adaptive command and control architectures in support of the Navy's new Maritime Strategy. - Continued research on quantitative formalisms for developing and assessing the completeness, consistency and accuracy of rules of engagement (ROEs). - Continued 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. - Continued research on models to support the design of scalable joint and coalition Maritime Operations Centers that allocate responsibilities to elements afloat and ashore. - Continued, 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 was conducted using DoD and academic laboratories capable of high fidelity mission simulation and precise measurements of independent and dependent measures - Developed cooperatively with the Air Force a series of networked laboratories for hybrid human-agent experimentation on multiechelon decision making and adaptive architectures for large maritime operations centers. - Investigated on Battlespace on Demand Decision Making: Operational Application of Meteorological and Oceanographic Data in Command Decision Making. 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Continued the development of advanced computational models capable of analyzing multidimensional 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. - Continued 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). - Continued effort to improve social network models to analyze merchant marine traffic. - Continued human cultural and social modeling to improve warfighting, civilian military operations and humanitarian operations in non-Western environments			
FY 2012 Plans: Human Computer Interaction/Visualization: - Continue all efforts of FY 2011 less noted above as complete. - Complete methods to introduce key cognitive abilities to autonomous vehicles that will enable warfighters and vehicles to work together more collaboratively. - Researched cognitive models of user interface affordance that could form the basis of usability analysis and evaluation. Collaboration and Knowledge Interoperability: - Continue all efforts of FY 2011. - Continue development of a computational model of teamwork, however shifted emphasis with issuing of two new grants. CMU will develop and apply novel machine learning algorithms to enable automated discourse analysis in order to identify teamwork processes and corresponding emergent leaders, and OSU will develop proxy agent technology to improve information exchange between emergent leaders and subordinates. - Continue development of metrics to measure team mental model convergence in order to assess teamwork performance in relation to mission success / outcome in submarine Command and Control. Shift emphasis to directly apply metrics to transition into the Capable Manpower Future Naval Capability. - Complete 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. - Develop the computational aspects of a model of tactical team decision making - Develop inclusion of the theoretical aspects of group cognition and knowledge building into the model of macrocognition. Organizational Design and Decision Support Systems: - Continue all efforts of FY 2011.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Continue model-based simulations and experiments to investigate effectiveness of hierarchical organizational structures in network centric operational environments with increased emphasis on modeling of tasks and information requirements for rapid mission planning and re-planning. - Continue research on adaptive command and control architectures in support of the Navy's new Maritime strategy with increased emphasis on dynamic task allocation based on mission phase and emergent mission requirements and impact to information requirements. - Continue development of Battlespace On Demand Decision Making for Meteorological and Oceanographic Command Decision making with increased emphasis on development of piracy prediction decision support and uncertainty characterization. Social Network Analysis: - Continue all efforts of FY 2011 - Complete the development of models capable of analyzing multidimensional networks with thousands of nodes. - Complete social network models of maritime domain. Completed social network analysis of merchant marine domain. - Support social complexity modeling for community dynamics (Stabilization, Security, Transition and Reconstruction problems (SSTR) and Humanitarian Assistance/Disaster Relief (HA/DR)), an outgrowth of computational social science/social network analysis in non-Western settings. Develop new techniques for model development fundamentals. Develop geo-spatial aspects of data presentation, modeling and visualization for improving decision tools in SSTR and HA/DR. - Develop information operations research on non-Western communities. - Research new methods to analyze, partition and filter massive datasets.			
FY 2013 Plans: Human Computer Interaction/Visualization: - Continue all efforts of FY 2012. Collaboration and Knowledge Interoperability: - Continue all efforts of FY 2012 less noted above as complete. - Continue development of computational model of teamwork with increased emphasis on agile management of mission objectives and team tasking. - Develop task management algorithms applicable to agile supervisory control of teams involving human and autonomous agents. Organizational Design and Decision Support Systems: - Continue all efforts of FY 2012 less noted above as complete. - Continue research on development decision support tools for MOC with increased emphasis on coordination across echelons in support of "Minesweeper to MOC" operations.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Continue research for design of Maritime Headquarters (MHQ) with MOC organizations with increased emphasis on design of information management tools and algorithm development for information prioritization. Social Network Analysis: - Continue all efforts of FY 2012 less noted above as complete. - Research new natural language prcessing methods to facilitate massive data collection using social media. - Research novel data collecting methods for SSTR and HA/DR.			
Title: KNOWLEDGE SUPERIORITY AND ASSURANCE	31.659	31.490	-
Description: 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, Tactical Networks and Network Control/Management, and Computer Network Defense and Information Assurance 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) 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. b) 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 other contingency operations 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. c) 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. d) 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
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). e) 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. f) 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 highbandwidth 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. g) 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 electrooptical, 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). h) Pro-Active Computer Network Defense and Information Assurance - Develop algorithms, protocols, and software that will allow the warfighter to 1)identify and counter real-time threats to the network during mission execution, 2) provide dynamic security management and component management of networked-based assets to support mission execution, and 3) ensure mission essential capabilities and data exist despite malicious cyber actions. i) Fast Magic - Develop algorithms and computer and information technologies for Naval forces to respond quickly against multiple threats. Details are classified. j) NRL Space - Develop vessel tracking fusion algorithms and software to integrate multiple modalities of informational elements including literal and non-literal information. Develop algorithms and techniques for handling incorrect, out of sequence and intermittent sensor data to provide persistent situational awareness.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
k) Advanced Tactical Data Link - Develop the Low Probability /Low Probability of Detection /Anti-Jam waveforms and aperture management functions needed to support Advanced Tactical Data Link operations in permissive, contested, and anti-access environments as well as the real-time network operations capabilities needed to dynamically add/remove participants, allocate Advanced Tactical Data Link resources to each participant, and add/remove network partitions in support of dynamic mission execution. l) Autonomous Tactical Persistent Surveillance - Develop the architecture, algorithms, software and knowledge product tools to allow autonomous control of persistent, tactical networks of sensors; enable ISR assets to provide an "Information Bubble" to the mobile user; provide revolutionary sensor and data support to agile tactical missions by anticipating information needs; and provide sensor planning and management relevant to a higher order knowledge model. This will provide the capability to autonomously maintain persistent surveillance of activities and entities over a region of interest, 24/7, while providing underlying context for real time adaptive surveillance in support of tactical mission objectives. The decrease of funding from FY 2012 to FY 2013 is the result of the transfer of resources from this R2 Activity to a new FNC PE 0602750N. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2011 Accomplishments:*** Automated Control of Large Sensor Networks: - Completed design of tools enabling mission-specific tactical sensor fields for at least two separate mission areas. - Completed design of tactical distributed data analysis and automated indications and warnings for 50% of tactical data. - Completed design of automated tactical platform and sensor planning and management sufficient for one operator to control multiple sensors. - Completed investigation of human to tactical sensor field interface to enable the user to locate relevant knowledge within 3 minutes. - Completed development of automated and mission aware large tactical sensor management engines and irregular threat and tactical sensor ontologies. - Completed development of the agents and other analysis applications enabling a fully netted tactical battlespace. - Completed demonstrations of mission-aware planning tools that allow large sensor networks to support tactical operations. OCO Focused Tactical Persistent Surveillance: - Continued 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Globally Netted Joint/Coalition Force Maritime Component Commander: - Continued 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. - Continued packaging of emerging common picture technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period. - Continued efforts for the mature common picture technologies that support naval requirements identified within the FORCEnet naval capability pillar. - Continued 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. - Demonstrated the dynamic distributed data layer, role-relevant representation and visualization, and adaptive collaboration assistant in a series of Limited Technology Experiments and Limited Technology Objectives to verify the ability to provide information flow in real time across theaters. Dynamic Tactical Communications Networks: - Continued effort to develop and apply emerging technologies that support self organizing networking and assured communications exchange in tactical communications networks. - Continued development of distributed-and dynamic policy based network management, secure mobility management solutions, and network service discovery mechanisms. - Continued 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. - Demonstrated distributed-and dynamic policy based network management and secure mobility management solutions, network service discovery mechanisms, and robust and bandwidth efficient group communication protocols for the tactical environment, including disruption tolerance. Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC): - Continued effort to develop new, and leverage emerging, technologies that support dynamic and response management and control of netcentric enterprise theater and tactical ASW operations. This includes automation support for synchronized planning of resources and multimission 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Continued 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. - Developed automated capabilities for generating multiple alternative course of action (COA) recommendations to the commander including automated development of force plans and allocation of related resources (e.g. sensors, platforms, weapons) and processes; and dynamic management and re-planning of tactical force goals, activities and resources. High-bandwidth Free-space Lasercomm: - Continued development of mitigation techniques for laser beam propagation through atmospheric turbulence and aerosol obscuration. - Continued 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 retroreflector optics. - Developed and demonstrated error correction methods and adaptive optics techniques for turbulence mitigation; and ultra-fast pulsing for obscuration. Actionable Intelligence Enabled by Persistent Surveillance: - Continued development of advanced analysis tools that are relevant to the information needs of tactical warfighters engaged against irregular actors. - Continued development of a multi-modal tactical wide area surveillance payload and sensors relevant to tier-2 UAVs that can detect other airborne platforms. Pro-Active Computer Network Defense and Information Assurance: - Developed Next Generation Sensors and Gateways to provide security and control mechanisms to protect networks, data and systems from attacks (e.g., malicious code, data exfiltration). - Developed Next Generation Security Protocols and Security Management Protocols to provide hardened, highly survivable, stealthy, reconfigurable overlay of protocols onto networks to ensure network-base configuration and control of security components essential to mission operations, as well as provide data provenance to support dynamic resource management and decision support. - Developed Common Operational Security Decision System to aggregate, correlate, fuse and visualize network security posture information to support integrated warfighting decisions. Fast Magic:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Developed algorithms and computer and information technologies for Naval forces to respond quickly against multiple threats. Details are classified. NRL Space: - Developed vessel tracking fusion algorithms and software to integrate multiple modalities of informational elements including literal and non-literal information. - Developed algorithms and techniques for handling incorrect, out of sequence and intermittent sensor data to provide persistent situational awareness. ***FY 2012 Plans:*** OCO Focused Tactical Persistent Surveillance: - Complete all efforts of FY 2011. Globally Netted Joint/Coalition Force Maritime Component Commander: - Complete all efforts of FY 2011. Dynamic Tactical Communications Networks: - Continue all efforts of FY 2011. Dynamic C2 for Tactical Forces and Maritime Operations Center (MOC): - Continue all efforts of FY 2011. High-bandwidth Free-space Lasercomm: - Continue all efforts of FY 2011. Actionable Intelligence Enabled by Persistent Surveillance: - Continue all efforts of FY 2011. Pro-Active Computer Network Defense and Information Assurance: - Continue all efforts of FY2011. Fast Magic: - Continue all efforts of FY 2011. Details are classified.			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Navy		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
NRL Space: - Continue all efforts of FY 2011. Details are classified. Advanced Tactical Data Link: - Developed low observable, low latency ad-hoc wideband networking waveforms for software defined radios. Autonomous Tactical Persistent Surveillance: - Develop a scalable, dynamic and distributed common architecture for ISR and C2 that allows sensors and data analysis nodes to anticipate the information needs of the tactical warfighter. - Develop algorithms to automate entropy-based control of a diverse body of collection assets - Develop algorithms for bandwidth-limited exploitation of multi-modal sensors across the distributed information space. - Develop automation tools that enable the understanding of entities, events, and relationships, ultimately leading to intent hypotheses. - Develop algorithms for automatic exploitation of domain knowledge within/between classes of environments - Develop algorithms to extract & synthesize adversary target information & quantify information gaps - Develop algorithms to automatically fuse enterprise archived information with dynamic contextual information - Develop algorithms to manage behavioral hypotheses based on regional activity history - Develop credibility models to aid inferencing process & characterize background normalcy			
Title: MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION	0.671	0.679	4.914
Description: 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. The increase from FY 2012 to FY 2013 is a result of the realignment of funds for Radar and Surveillance efforts to the from the Applied Information Sciences for Decision making R2 Activity. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2011 Accomplishments:*** - Continued the development of a new radar signature analysis technique based on nonlinear dynamics. - Continued development of coordinated multi-platform, multi-component waveforms. - Continued development of a real-time electronic warfare support deinterleaving capability. - Continued development of advanced communications emitter identification.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Completed 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. - Completed 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. - Continued to develope and demonstrate Multiple Input Multiple Output (MIMO) radar concepts and technology using High Frequency (HF) Skywave radar. - Completed improvements in the resolution of the High Frequency Relocatable Over-the-Horizon Radar (HF-ROTHR) more than two orders of magnitude using time-reversal methods. ***FY 2012 Plans:*** - Continue all efforts of FY 2011 less noted above as completed. ***FY 2013 Plans:*** - Continue all efforts of FY 2012.			
Title: TACTICAL SPACE EXPLOITATION ***Description:*** 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. a) Tactical Space Exploitation Innovative Naval Prototypes: 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. b) Spacecraft Technology: Affordably expendable payload and bus technologies will be developed, which 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 following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2011 Accomplishments:*** Tactical Space Exploitation Innovative Naval Prototypes:	4.214	4.261	4.377

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Completed development of integration plans, algorithms, and satellite concept of operations to demonstrate integrated signals payload. - Completed development of small multifunctional integrated signals electronics systems for ship tracking from space and two-way data exfiltration from distributed global sensors. Spacecraft Technology: - 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. - Continued effort to develop technologies using autonomous bi-dexterous manipulation for closeproximity operations in space. - Continued developing the underlying fluid transfer technologies for steerable radiators that will enable spacecraft thermal radiators to be pointed away from the sun. - Continued developing a proof-of-concept, reliable touch sensitive skin for robotic arms with emphasis on space applications, and the associated fault detection and model identification algorithms required to utilize it. - Completed the development of a preliminary design for electrodynamic propulsion technology demonstration spacecraft. - Developed artificially generating and maintaining a dust layer in the near-earth plasma environment to induce enhanced drag on space debris towards debris mitigation. ***FY 2012 Plans:*** Spacecraft Technology: - Continue all efforts of FY 2011 less noted above as complete. ***FY 2013 Plans:*** Spacecraft Technology: - Continue all efforts of FY 2012.			
Title: INFORMATION SECURITY RESEARCH ***Description:*** The overarching objective of this activity is to protect the Navy and the Joint information infrastructure from hostile exploitation and attack and this activity transfers from PE 0603235N effective FY 2013. The current specific objectives are: a) Network Situation Awareness & Security: Develop tools, techniques and methodologies to improve network resistance to denial of service attacks and improve indications and warnings of suspect activities. b) Network Traffic Analysis and Assessment: Develop methods for conducting network traffic analysis; monitoring and assessing network status and health; identifying new capabilities to analyze network vulnerabilities and attacks; and providing situational awareness of network assets and operations.	-	-	1.889

Exhibit R-2A, RDT&E Project Justification: PB 2013 Navy		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
c) Information Assurance: Develop and measure the effectiveness of Information Assurance (IA) protective solutions and improve the quality and level of certification of information assurance software. The following accomplishments and plans are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2013 Plans:*** Network Situation Awareness & Security: - Continue development of algorithms/methods for providing attribution of threat-agents through the network/infrastructure. Emphasis will be placed on addressing translational boundaries, cross-domains, and obfuscation techniques to avoid detection and tagging. - Continue the development of new algorithms to link/mine disparate system/network activities in order to identify malicious/threat agent actions against infrastructure components/systems. - Develop new mobile agent technology that provides network protection, thwarts botnet attacks, and provides for a resilient computational infrastructure and communications environment. Investigate new methods for subverting the control plane of the mobile code attacking the infrastructure. Network Traffic Analysis and Assessment: - Continue the development of new algorithms focused on detection of nation state sponsored activities through the network infrastructure. Develop algorithms to address sophisticated malicious code techniques that exploit network traffic/data that is fragmented, encrypted, and/or obfuscated using polymorphic methods, as well as techniques that transgress security perimeters and exfiltrate data. Information Assurance: - Continue enclave boundary security controller to protect Navy networks from attack and exploitation with emphasis on addressing malware detection, data exfiltration, general attack detection, network reconstitution, exploitable cross-infrastructure dependencies.			
Title: AUTONOMOUS SYSTEMS AND ROBOTICS	-	-	6.041
Description: The Autonomous Systems and Robotics initiative explores the application of new technologies to advance capabilities in the area of robotics, autonomous systems propulsion and control, and integration of autonomous systems. Efforts will be focused on the Secretary of Defense (Research and Engineering) (ASD(R&E)) priorities in autonomous systems. FY13 funds are for acceleration efforts in Autonomous Systems and Robotics.			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Navy		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602235N: *Common Picture Applied Research*	PROJECT 0000: *Common Picture Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
FY 2013 Plans: Robotics Platform Research: This addresses development of autonomous robotic systems capability to interact with and service other platforms and autonomous vehicles. Micro-Robotic Servicing - advanced highly dexterous control of extremely lightweight and flexible robotic arms, with specific application to EOD, surveillance and on-orbit servicing robotic communities. This research would extend ongoing research in lightweight robotic arms. Autonomous Refueling - development of hardware, algorithms, and sensors for hybrid rigid-compliant robotic arms in rapidly changing environments, with specific application to autonomous refueling of USVs, UAVs and UGVs while moving in their environments, advancing beyond the DARPA-sponsored "Rapid Autonomous Fuel Transfer Project". Low Power Micro-robotics - development of onboard sensors, control electronics, and actuators requiring very low power, with specific application to robotic missions over long durations. Advanced Manipulators and Tool-Changers - development of innovative robotic manipulators, tool changers, and associated sensors for challenging robotic manipulation tasks, with specific application to EOD and other robotic missions in difficult environments. This research would extend previous research by providing robust end effector technology and tool changing capability. The overall research outcomes will enhance DoD capability in the areas of explosive ordnance disposal, autonomous vehicle refueling, and innovative robotic arm control. Research deliverables will include hardware development in the areas of lightweight robotic arms, end effector tools and tool changers, and low power electronics and actuators. Autonomous Vehicles: - This effort will draw from current research and push the technology development to the next level to provide a leap-ahead capability in long endurance, deployable, autonomous, robotic air vehicle using fuel cell electric propulsion systems for high efficiency, even in small vehicles, which can provide robust airborne sensor capabilities for submarines, UUVs, small naval platforms and small dismounted units. Undersea Vehicles: - Funding would be used to acquire a medium sized (12.5 inch diameter) Autonomous Underwater Vehicle as an at sea test platform to advance the state of art of onboard intelligent autonomy. This medium sized UUV is readily amenable to vehicle and sensor testing in the wave pool in the Laboratory for Autonomous Systems Research facility. Subsequently, this would allow			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
at sea testing of State of the art autonomy algorithms (e.g. goal driven autonomy, human cognitive models, Markov decision processes) that allow Navy underwater vehicles to carry out complex mission in denied areas by understanding the environment and adapting mission goals in the context of the commander's intent, with little or no human operator intervention. Autonomous Systems Integration: - To support the Assistant Secretary of Defense (Research and Engineering) (ASD(R&E)) priorities in autonomous systems, and specifically to advance the state of the art in heterogeneous teams of autonomous platforms, (including sensor networks and mobile communication nodes) that can work seamlessly with the warfighter, funding will be applied to small air platforms and militarily relevant unmanned ground vehicles to integrate sensors and advanced power sources, and to develop the autonomy software that allows the individual platforms to work together, as well as to work at a peer-to-peer level with the warfighter. This includes advanced human-robot interaction techniques and information processing and presentation techniques that reduce the warfighter's cognitive load and allows him to work with a team of autonomous systems.			
Accomplishments/Planned Programs Subtotals	68.155	65.184	41.696

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

This PE supports the development of technologies that enable the transformation to network centric warfare. Net-centric operations include communications and information assurance capabilities to enable all-source data access, tailored dissemination of information to Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) users across the network, and rapid, accurate decision making based on this information. 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.

Specific examples of metrics under this PE include:
- Increase network data rates and interoperability across heterogeneous radios; improve dynamic bandwidth management and mobile network connectivity.
- Increase the understanding of the battlespace by the development of automated tools for extracting information from images and signals, identifying objects, determining relationships among the objects, assessing intent, and generating courses of action.
- Improve human-factors design principles resulting in enhanced human performance effectiveness, improved timeliness and quality of decision making, reduced manning, and improved team decision making in ad-hoc, complex problem solving scenarios.
- Improve the integration of sensors, networks, decision aids, weapons, and supporting systems into a highly adaptive, human-centric, comprehensive maritime system.

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- Improve integrated signals electronics packages small, light-weight, and low-cost satellites to test new concepts for global ship tracking and two-way data exfiltration.