RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2005	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Network-Centric Warfare Technology PE 0603766E, R-1 # 51				
COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	82.185	121.613	136.899	176.855	194.101	200.066	205.066	215.066
Joint Warfare Systems NET-01	25.063	35.090	60.787	93.405	90.550	93.657	95.657	105.657
Maritime Systems NET-02	9.076	34.327	33.426	38.532	48.774	51.839	53.839	56.839
Classified NET-CLS	48.046	52.196	42.686	44.918	54.777	54.570	55.570	52.570

(U) Mission Description:

(U) The Network-Centric Warfare Technology program element is budgeted in the Advanced Technology Development budget activity because it addresses high payoff opportunities to develop and rapidly mature advanced technologies and systems required for today's network-centric warfare concepts. It is imperative for the future of the U.S. forces to operate flawlessly with each other, regardless of which Services and systems are involved in any particular mission. The overarching goal of this program element is to enable technologies at all levels, regardless of Service component, to operate as one system.

(U) The Joint Warfare Systems project will create enabling technology for seamless joint operations from high-level, strategic planning to low-level, tactical operations in all environments: urban, suburban, and rural areas. The operational benefits of this project will be an enhanced ability to counter opponents' capabilities, not just facilities and equipment. This project includes efforts at the strategic/operational level that generates targeting options against opponents' centers of gravity having complex networked relationships, the operational/tactical level that manages highly automated forces with tight coupling between air and ground platforms, and the focused tactical level that develops targeting platforms that can acquire targets of opportunity cued by network-based analysis of likely enemy operations. Programs in the project are closely coordinated with those in project NET-02 of this program element and those in PE 0603764E, Land Warfare Technology.

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(U) The Maritime Systems project will identify, develop and rapidly mature critical advanced technologies and system concepts for the naval forces' role in today's network centric warfare concept. Naval forces play an ever-increasing role in network centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea and their versatile ability to provide both rapid strike and project sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network centric forces. Programs in this project are closely coordinated with those in project NET-01 of this program element.

(U) **Program Change Summary:** *(In Millions)*	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**
Previous President's Budget	91.226	125.124	141.257	199.796
Current Budget	82.185	121.613	136.899	176.855
Total Adjustments	-9.041	-3.511	-4.358	-22.941
Congressional project reductions	0.000	-3.511		
Congressional increases	0.000	0.000		
Reprogrammings	0.000	0.000		
SBIR/STTR transfer	-9.041	0.000		

(U) Change Summary Explanation:

FY 2004	Decrease reflects SBIR/STTR transfer.
FY 2005	Decrease reflects congressional undistributed reductions.
FY 2006 - 2007	Decrease reflects program adjustments in Project NET-CLS, classified programs.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Network-Centric Warfare Technology PE 0603766E, Project NET-01				
COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Joint Warfare Systems NET-01	25.063	35.090	60.787	93.405	90.550	93.657	95.657	105.657

(U) Mission Description:

(U) The objective of the Joint Warfare Systems project is to create enabling technologies for seamless joint operations, from strategic planning to tactical and urban operations. Joint Warfare Systems leverages current and emerging network, robotic, and information technology and provides next generation U.S. forces with greatly expanded capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents utilizing systems that are flexible, robust, and difficult to neutralize; and (2) U.S. doctrine that limits the use of firepower to lessen the impact of operations on noncombatants. These problems are magnified in urban and semi-urban areas where combatants and civilians are often colocated, and in peacekeeping operations where combatants and civilians are often indistinguishable. Meeting these challenges places a heavy burden on joint war planning. Understanding opponent networks is essential so that creative options can be developed to counter their strategies. Synchronization of air and ground operations to apply force only where needed and with specific effects is required. This project supports all levels of the force structure including: (1) the strategic/operational level by generating targeting options against opponents' centers of gravity that have complex networked relationships; (2) the tactical/operational level by managing highly automated forces with tight coupling between air and ground platforms; and (3) the focused tactical level by developing platforms, which acquire targets of opportunity, cuing network-based analysis of likely enemy operations and developing warfighter tools, thus maximizing the presence of ground forces in Stability and Support Operational (SASO) environments.

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(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Network Command	13.813	16.085	16.883	19.516

(U) The Network Command program leverages recent advances in network computing to dramatically improve collaboration among physically separate command posts. The program allows commanders and their staffs to share situation information, develop coordinated battle plans, generate and compare alternate courses of action, and assess likely outcomes, without conventional group briefings. Network Command builds on the paradigm established by the Command Post of the Future program, which demonstrated to commanders, working with voice-over IP and robust graphical collaboration software, a coherent understanding of a situation and operational plan without any face-to-face interactions.

- Command Post of the Future (CPOF) is currently deployed with multiple Army Divisions in support of Operations Iraqi Freedom (OIF). CPOF is scheduled to transition to the Army Program Executive Office Command, Control, and Communications Tactical (PEO C3T) in April 2006. This program created a system with radical new capabilities for improving decision making by operational commanders, providing dynamic tailored visualization and deep collaboration tools for improved situation awareness and course-of-action development and dissemination. The program will introduce a radical new concept for future command environments, namely, the elimination of the fixed command post that will be replaced by battle command on the move. Introduction of the tools developed under this program will allow future command structures to be mobile and distributed, thus enabling reduction of staff sizes and allowing commanders to operate effectively while on the move.

- The Multiuser, Adaptive Command Environment (MACE) program is an outgrowth of the Command Post of the Future (CPOF) program that will make collaborative tactical command more adaptive, cross-functional, and scalable. The program provides monitors in the collaboration environment to observe data traffic, identify patterns, and proactively move information through the system to more rapidly meet user's needs. MACE allows users to be distinguished by their military function – intelligence, maneuver, fires, security, logistics – and tailors displays and communication modes to those functions. Finally, the technology scales the environment from dozens to hundreds of workstations operating over a diverse set of tactical communication networks.

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- The Network-Centric Situation Assessment program develops and deploys technologies to assess military situations at levels of interest above individual targets. The program uses all-source data to reconstruct unit organizations, mission relationships, logistics connections, and communications connectivity and analyzes data over time to infer movement, communication, and supply patterns. Within this context, capability analyses are provided and future courses of action are hypothesized. The objective is to understand potential capabilities and intentions of opposing forces. This effort provides greater understanding of opponents' force structures, capabilities, and operational practices, then enables commanders to sustain effects-based targeting rather than simple attrition strategies. The program provides a context for discovering vulnerabilities in opposing forces and provides cues for intelligence, surveillance, and reconnaissance planning, as it suggests areas of future enemy activity that merit intense scrutiny.

- The Joint Mission Rehearsal program integrates high-fidelity; mainframe-based combat simulations with situation assessment and planning tools. The objective is to allow rehearsal of joint missions, while participants are en route to operations or remain at their home stations. The program uses current situation data to: (1) provide initial conditions for the simulations, and (2) plan data to steer the dynamics of the simulations along the selected courses of action. The technology streams data from the simulations for display, then visualization systems are available to the prospective participants. The visualization permits the warfighter to interact with the simulation in a manner consistent with their anticipated role in the mission being rehearsed. The program delivers the capability to practice and fine-tune mission plans for joint military operations and enables commanders and staff to participate from their current location instead of a training facility, thereby reducing deployment needs while improving mission planning and effectiveness.

(U) Program Plans:

– Command Post of the Future.
  -- Instrument the deployed CPOF software to record data from field use.
  -- Develop analysis tools to reconstruct information paths.
  -- Design system management tools to restructure information flows to meet decision needs.

– Multiuser, Adaptive Command Environment.
  -- Collect data from field operations describing information flows, timing, and decision patterns.
  -- Identify patterns in those data corresponding to decision cycles and special tasks.
  -- Develop techniques to proactively move information among workstations to reduce latency while maintaining consistency.
  -- Scale the underlying technology to operate over both current and emerging tactical communications systems.

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– Network-Centric Situation Assessment.
  -- Identify data fields available to a representative theater commander.
  -- Apply advanced link-analysis and pattern-matching technology to tactical data.
  -- Evaluate technologies using real-world data.

– Joint Mission Rehearsal.
  -- Enhance existing mission simulations to require "red cell and white cell" participants.
  -- Develop tools to rapidly assemble new mission scenarios from existing data sources.
  -- Develop techniques to infer data needed by the simulations.

	FY 2004	FY 2005	FY 2006	FY 2007
Precision Urban Combat Systems (PUCS)	0.000	4.000	10.423	22.565

(U) The Precision Urban Combat Systems (PUCS) is developing and validating advanced sensor, exploitation, networking, and battle management capabilities for joint dismounted forces in urban combat. The program includes detection and tracking of potential enemy targets, discrimination and identification of friendly versus enemy units, sorting of enemy from neutral and non-combatant personnel, coordination of sensing, maneuver, and fires, and continuous assessment of results. PUCS will utilize technologies including: smart networks of distributed imaging and non-imaging sensors; sensors with the capability to detect hidden human targets; improved 3D visualization systems, multi-spectral discrimination systems that survey the battlefield for weapon activity and detect primary signatures. These capabilities will be developed within the framework of both legacy forces and expected future forces. The program will provide a set of prototype demonstrations of the capabilities in surrogate urban combat environments.

- The Robust, Persistent 3D Urban RSTA (reconnaissance, surveillance and target acquisition) program addresses the very difficult technical challenges to provide situational awareness capabilities that will assist the warfighter in identifying and defeating enemy threats. This includes the ability to robustly detect and persistently track all-source targets in the highly cluttered, 3-dimensional urban landscape (outdoors and indoors). This program will demonstrate an innovative active radio frequency (RF) sensor network technology that uses broadband, short-pulse active RF technologies for low power precision radar and communications, exploits multi-static operation for robust 3-D target detection, localization and tracking, and provides distributed sensor fusion for target characterization.

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- The Firefight Aerial Sensor and Mapper program will develop a new adaptive optical-acoustic sensor fusion system to identify the 3D dynamic locations of red and blue forces in continually updated 3D models of the urban landscape. The program will use a small number of UAVs (1-4) equipped with multi-modal sensor suites (IR, acoustic arrays) and rapidly updated 3D imagery. By detecting weapon discharge events, approximations of individual shooter locations are combined in order to obtain an informative overall picture of the emerging battlefield.

- The Smart Dust Sensor Networks Applied to Urban Area Operations Program will provide persistent staring reconnaissance, surveillance, and target acquisition (RSTA) of the three-dimensional urban battlespace using a dense network of ground sensors. The system concept consists of ubiquitous and inconspicuous low-power, small and easily concealed ground sensors throughout the urban landscape. The program includes the development of ultra small sensor nodes for easy deployment and concealment in a crowded urban environment and data fusion algorithms to exploit the abundance of new information provided by a dense urban spatial network.

- The Head Mounted Alerting for Urban Operations program will provide unprecedented situation awareness capabilities to the warfighter without flooding the individual with excess information. The program will develop an intrusive alerting system that will allow a soldier to patrol and/or operate in an urban environment while being interrupted only by urgent and highly relevant situation awareness information. The program will employ an information management engine that filters, prioritizes, and presents diverse and copious amounts of situation awareness data, generically referred to as 'alerts', in accordance with a set of correlation rules created by each individual soldier. The filtering will be specialized to individual warfighter's roles and responsibilities and automated so the warfighter does not have to make real-time complicated adjustments to their tools when a dangerous situation erupts.

- The Exploiting Vibrations to Monitor Activities in Buildings program will develop procedures and sensors to characterize activity inside structures based on acoustic/seismic information. The types of information sought include number and location of personnel, foot traffic, operation of building mechanicals (ventilation, cooling, and heating; plumbing; etc.) as an indicator of human activity, operation of other machinery, door openings and closings, and speech. Algorithms that infer internal layout of the building from the pattern and location of these activities will be investigated along with the fusing of the information from other surveillance information gained by other sensing modalities.

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(U) Program Plans:

– Robust, Persistent 3D Urban RSTA.
  -- Collect Ultra-wide band target and background signatures.
  -- Develop and demonstrate technologies to separate targets from background.
  -- Test at a representative Military Operations on Urban Terrain (MOUT) site.

– Firefight Aerial Sensor and Mapper.
  -- Develop prototype sensor system.
  -- Collect weapon discharge and background signatures.
  -- Develop battlefield activity summarization logic.
  -- Demonstrate at a representative MOUT site.

– Smart Dust Sensor Networks Applied to Urban Area Operations.
  -- Develop miniaturized sensors based on Network Embedded Systems Technology (NEST) concept.
  -- Develop and demonstrate technologies to separate targets from background.
  -- Develop battlefield activity alert logic.
  -- Demonstrate at a representative MOUT site.

– Head Mounted Alerting for Urban Operations.
  -- Create information filters that sort situation relevant data from background.
  -- Develop and prototype mechanisms to sense soldier's activity and situation intensity.
  -- Demonstrate at a representative MOUT site.

– Exploiting Vibrations to Monitor Activities in Building.
  -- Collect acoustic/seismic data from a set of sample buildings.
  -- Develop and demonstrate technologies to separate targets from background and summarize activity.
  -- Demonstrate at a representative MOUT site.

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	FY 2004	FY 2005	FY 2006	FY 2007
Effects Based Network Targeting	4.253	5.877	2.062	0.000

(U) The Effects Based Network Targeting program develops technology to identify, determine vulnerabilities, target, and anticipate workarounds in enemy networks. These techniques use all-source information to continuously update models of urban networks (e.g., transportation, energy). An aim is to elicit operational objectives for urban interventions, expressed in terms of desired and undesired effects. The technology will use these objectives to find vulnerabilities in the networks, then nominating targets for prosecution so as to maximize desired effects while minimizing undesired effects. Further, the program develops techniques for predicting those observables that will rapidly identify an opponent's response when several courses of action are available. The program enables warfighters to develop effects-based target sets at forward command nodes and provides commanders a means to anticipate and counter an opponent's workarounds. Finally, Effects Based Network Targeting minimizes undesired effects by anticipating downstream consequences and selecting targets with low risk of collateral damage, permitting targeting operations to proceed, even within restrictive rules of engagement.

(U) Program Plans:

- Develop tools to: (1) extract relevant information from source data (especially signals, text, and imagery); (2) correlate that information to existing models; (3) update the models while resolving conflicts among sources; and (4) analyze the overall effect of newly discovered changes.
- Design tools to analyze networks, singly and in combination, in order to identify vulnerabilities to predict effects of candidate interdictions.
- Demonstrate selected tools on real-world cases, validating against historical and natural situations.

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	FY 2004	FY 2005	FY 2006	FY 2007
Confirmatory Hunter Killer System	6.997	9.128	9.741	12.481

(U) The Confirmatory Hunter-Killer System program is developing a low-cost, expendable loitering weapon/unmanned air vehicle for deployment along lines-of-communication or near critical facilities (e.g., suspect underground facilities). The objective is to provide localized surveillance against limited (one or two) specific targets. The vehicle employs two on-board electro-optics/infrared sensors and downlinks data to a control device containing target designation capability to confirm engagement with a human operator. The program provides image-based target acquisition capability, permitting suppression of non-emitting targets, emerging targets, and threats to lines of communication and other delimited regions. The program enables suppression of targets emerging from suspect underground facilities, thus providing the capability to suppress pop-up electronic warfare threats, before having an opportunity to emit. The Confirmatory Hunter Killer System is planned for transition to the Army, at the conclusion of Phase II anticipated to be completed by FY 2007.

(U) Program Plans:

- Characterize component capabilities (platform, sensor, and onboard automatic target recognition and data links).
- Develop and analyze alternative designs, using high-fidelity simulation and analysis tools in a variety of joint mission contexts.
- Select combinations of components that achieve the most effective system capabilities.
- Develop a brass-board platform, mountable on a standard test aircraft; verify sensor, automatic target recognition, and data link performance.
- Tailor and improve component capabilities to reduce manufacturing cost, while preserving effectiveness.
- Construct prototype vehicles and conduct field tests.

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	FY 2004	FY 2005	FY 2006	FY 2007
SASO and Patrolling Enablers Yielding Enhanced Security (SPEYES)	0.000	0.000	4.133	10.631

(U) The Stability and Support Operations (SASO) and Patrolling Enablers Yielding Enhanced Security (SPEYES) program develops and integrates a set of warfighter technologies into a comprehensive system tailored to enhance the effectiveness of U.S. forces in post-conflict military situations. These technologies act as force multipliers, allowing a small number of ground troops to exert influence comparable to larger forces without SPEYES. Core technologies include: 1) distributed, persistent multi-spectral cameras, 2) continuous, dynamic scheduling of patrols, and 3) tools for understanding rapidly evolving situations. When integrated, these technologies allow forces to provide security from three critical perspectives: 1) military policing (e.g., looters, thugs, black market activities), 2) force protection (including convoy security, command center, and base security), and 3) critical infrastructure protection (e.g., protection of oil pipelines, ports, borders). The SPEYES system is being tested against a range of scenarios and assessed for its ability to establish security and stability quickly which is critical for the eventual reconstruction effort.

(U) Program Plans:

- Establish a SPEYES testbed at a facility that supports company-level training in security operations.
- Develop prototypes of selected SPEYES technologies.
- Plan, conduct, and evaluate controlled experiments at the testbed to ascertain appropriate operational concepts of employment.
- Refine and ruggedize the design of selected prototypes.
- Conduct semi-annual evaluations of the refined designs in platoon-level exercises.
- Coordinate with Army and Marine program offices for transition to field use.

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	FY 2004	FY 2005	FY 2006	FY 2007
Multi Dimensional Mobility Robot (MDMR)	0.000	0.000	8.000	10.240

(U) The MDMR program will investigate concepts using serpentine mobility to achieve new ground robot capabilities for search and rescue applications. The MDMR system will traverse complex urban terrain for search and rescue. Examples of the capability include: overcoming obstacles that are a significant fraction of its length, crossing slippery surfaces, and climbing steep slopes. The MDMR platform will be able to support a variety of search missions in hazardous environments such as urban rubble piles. To achieve such a degree of mobility, design concepts must address system challenges such as: on board power management; situational awareness; complex terrain navigation; and system controls.

(U) Program Plans:
- Demonstrate serpentine mobility from a base level approach.
- Integrate the robotic system and user interface control.
- Develop and test tele-operation control.
- Perform rigorous testing to characterize system performance and spiral new technology developments into the existing platform.
- Transition platform to search and rescue users and demonstrate new capabilities.

	FY 2004	FY 2005	FY 2006	FY 2007
RADAR Flashlight	0.000	0.000	4.500	6.000

(U) Current shortfalls exist in our capability for through-the-wall (TTW) detection or localization of adversaries or hostages in urban environments. Other programs are developing fixed multi-node / multistatic systems for synoptic surveillance of building interiors. The goal of this program is to develop a tactical portable handheld system that can be used to detect unique quasi-narrowband countermeasure-resistant signatures associated with enemy combatants and hostages through walls and doors using high gain processing. Range and angle resolution plus blind statistical signal separation techniques will be used to determine location and number of occupants.

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(U) The primary technical obstacles are a) miniaturization of sensor and signal processing, b) "virtual" platform stabilization using differential processing from stationary objects in field of view, and c) selection of optimum frequency for penetration, target discrimination and gain, and d) separation of multiple targets using both spatial and temporal processing using statistical signal separation techniques. This program is an outgrowth of "Building Structure and Activity Assessment" under PE 0603767E, Project SEN-01.

(U) Program Plans:
- Evaluate candidate designs for RF and signal processing components.
- Carry out feasibility measurements and modeling.
- Design, build, and test prototypes for use in full-scale demonstration of the concept.

	FY 2004	FY 2005	FY 2006	FY 2007
Network Centric Logistics	0.000	0.000	5.045	11.972

(U) The Network-Centric Logistics program will develop, integrate and evaluate technologies to control and optimize the overall supply flow and inventory strategies for logistics support. The technology enables logistics flows both horizontally and vertically across the joint battlefield, allowing different commodity flows to operate as complex adaptive networks, rather than as fixed logistics chains. By viewing the supply situation as a network, with feedback as well as feedforward paths, these technologies increase responsiveness to dynamically changing needs within low echelon operating areas. Key technologies include: (1) in-inventory sensors to determine supply usage rates within mission context, (2) predictive demand models to forecast emerging needs based on a unit's operational plan, (3) agent-based negotiation protocols with provable stability, and (4) transport planning technology to enable unconventional commodity flows.

(U) Program Plans:
- Extend existing logistics simulations to include nontraditional transport mechanisms and their coupling to combat operations.
- Develop adaptive demand models driven by historical material expenditure rates and predictive operations plans.
- Implement functional models of new inventory sensing technologies.
- Define an agent-based computing architecture, aligning agents with decision nodes in a future logistics organization.
- Develop decision protocols for insertion into the agents.

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- Exercise the decision protocols against a variety of combat scenarios.
- Conduct field evaluations of the technology in parallel with Service training exercises.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Maritime Systems NET-02	9.076	34.327	33.426	38.532	48.774	51.839	53.839	56.839

(U) Mission Description:

(U) The objective of the Maritime Systems project is to identify, develop and rapidly mature critical advanced technologies and system concepts for the naval forces' role in today's network centric warfare concept. Improvements in communications between and among submarines, surface ships and naval aircraft have allowed these forces to operate seamlessly with each other and with other Service's network centric systems. Naval forces will play an ever increasing role in network centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea and their versatile ability to provide both rapid strike and project sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network centric forces. This project funds the Mobile Undersea Distributed System (MUDS) program, the Jet Blast Deflector program, the Non Linear Dynamics for Anti-Submarine Warfare (ASW), and the Reduced Size, Affordable Submarines technology demonstration program.

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Mobile Undersea Distributed System (MUDS) Program	9.076	25.927	19.426	20.032

(U) The Mobile Undersea Distributed System (MUDS) program goal is to enhance operations in the littorals to counter asymmetric threats posed by diesel submarines and other forces operating in the littorals, by distributing countering capabilities throughout a complimentary and networked system of sensors and platforms. The network-centric MUDS program includes the Sea Sentry effort, the Persistent Ocean Surveillance effort, Warfighting in the Littoral effort the Aluminum Combustor effort, the River Eye effort and the Compact Aperture Ranging Passive Sonar effort.

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(U) The Sea Sentry effort will investigate and demonstrate an underwater, distributed sense and effect system to detect and localize difficult undersea targets such as submarines employing advanced air-independent propulsion technologies. Using covert, mobile, and energy-efficient vehicles, the tactical gain available from the collective intelligence behavior of a swarm of individual agents will be demonstrated. This effort will develop technologies in the areas of agent-based autonomous control; vehicle navigation; high data rate/low-power underwater communications; network management and optimization; sustainable energy concepts; and low power sensing/signal processing enabling covert persistent underwater surveillance in denied areas. The military utility of underwater gliders will be demonstrated in a sensor system that is configurable in 3D, adaptable to the physical environment for sensing and communications, sustainable by getting its on-station locomotion and 'staying power' from the environment, self-configurable using sensory feedback, and self-optimizing using efficient dynamic network management techniques.

(U) The Persistent Ocean Surveillance effort will combine geolocation techniques such as the global positioning system with station keeping and intra-sensor communication technologies to provide long-term station keeping ocean environment sensing buoys. These technologies when applied with state-of-the-art undersea warfare sensors will result in a floating field of smart sensors capable of observing the undersea environment in an area, including the presence of submarines and other undersea vehicles. A range of technologies will be considered including those that rely on the local environment (such as wind, solar energy, temperature differentials, etc.) for their power, miniature geolocation technologies, and technologies for sensor data storage, transmission, and intra-field communications. The Persistent Ocean Surveillance-Station Keeping technology is planned for transition to the Navy is anticipated in FY 2008.

(U) The Warfighting in the Littoral effort is the vehicle for investigating and developing technologies recommended by the joint DARPA/Navy Littoral Naval Force Architecture Study that explored future concepts and potential technologies for rapid access and successful operation in contested areas defended by forces ashore, mines, submarines, small craft, and anti-ship missiles. The technologies developed will directly affect the ability of Naval Forces to accomplish missions in the world's littorals—some may involve significant technical obstacles that, if overcome, would lead to dramatic improvement in capability. Potential transition targets include a broad spectrum of existing and future naval programs. DARPA established an MOA with the Marine Corps for this program in October 2004.

(U) The Aluminum Combustor (formerly Vortex Combustor in PE 0603763E, Project MRN-02) effort seeks to develop an energy-dense air independent underwater power source as a potential propulsion system for underwater vehicles. The Aluminum Combustor technology is anticipated for transition to the Navy in FY 2007.

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(U) Early entry maritime forces need maps of morphology, water depths, and currents in complex riverine/estuarine environments for mission planning and execution. This information is critical for route planning, sensor placement, rendezvous determination, vulnerability assessments, and for determining objective assault engagement/disengagement strategies. For uncharted and/or denied areas, present methods are inadequate for obtaining the necessary information. Reliable remote sensing methods do not exist that produce bathymetry and water current data in waters that are sediment laden (bottom is not visible) and/or sheltered (swell and significant wind waves are not likely). The River Eye effort will provide a new capability to predict or assess, in real time, river and estuary conditions to enable special operations mission planning and execution. New techniques will be developed to indirectly determine current by remotely-sensing advection of scene features. Using advanced modeling techniques indirectly sensed current data will be used to extract bathymetry data. Forward circulation models will use the bathymetry data to predict future currents and water heights in a mission planning decision support tool.

(U) The ability of U.S. Navy submarines to maintain situation awareness and tactical advantage in shallow water is compromised by an inability to safely deploy the highest-capability acoustic sensor, the long towed array. The Compact Aperture Ranging Passive Sonar (CARPS) effort will provide towed array capability in a compact hull or dome-mounted sonar aperture. CARPS will exploit non-acoustic shear waves induced in the material of a small aperture by external acoustic energy. The program will investigate practical beamforming techniques, the effect of acoustic and non-acoustic noise on performance, and the ability to resolve multiple acoustic sources.

(U) Program Plans:

- Mobile Undersea Distributed Systems
  - Continue investigation into novel communications and networking concepts.
  - Explore concepts to reduce platform infrastructure and, ultimately, the cost of future design and production of submarines.

- **Sea Sentry**
  - Assess concepts employing swarms of undersea vehicles with acoustic and non-acoustic sensing modalities for detecting and tracking submarines with air-independent propulsion (AIP) systems.
  - Demonstrate autonomous control approaches for individual and groups of undersea vehicles.
  - Develop prototype low-cost, low-power, sensor/signal processing system, undersea sensor communications, and an underwater sensor localization and navigation capability.

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  - Perform design trade studies, including: hydrodynamic performance modeling for advanced undersea vehicles concepts and advanced propulsion systems concepts.
  - Assess concepts for precise sensor localization and navigation systems.
  - Design and prototype a system of undersea autonomous with sensor modalities, communications, and navigation for detecting and localizing submarines equipped with AIP technology.
  - Demonstrate system performance at sea.

- Persistent Ocean Surveillance
  - Explore the scientific/engineering issues associated with station keeping.
  - Develop a long endurance tactical sized ocean surveillance buoy using exploitable local environmental effects for station keeping.
  - Demonstrate performance at sea.

- Warfighting in the Littoral
  - Continue investigation into technologies for detection, precision identification, tracking and destruction of elusive surface, subsurface and air targets.
  - Refine and update impact assessment of introducing networked manned and unmanned systems, cognitive systems, and robust, secure self-forming tactical networks into the Navy's future warfighting capability concepts.

- Aluminum Combustor
  - Conducted several test firings of the Vortex Combustor system.
  - Conducted analysis and performance evaluation.
  - Demonstrated slag free, 15-minute endurance runs of a redesigned Aluminum Combustor engine.

- River Eye
  - Assess required sensor modalities, develop modeling techniques, and conduct field experiments in mixed estuary environments to establish proof of concept.

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- Conduct field experiments in stratified estuaries, incorporate environment data into model, and develop prototype mission planning application.
- Integrate sensor(s) onto airborne platform, conduct instrumented data collections in well mixed and stratified environments, and complete prototype mission planning system.
- Conduct real time at sea demonstration.

- Compact Aperture Ranging Passive Sonar (CARPS)
  - Demonstrate the concept through analysis and simulation.
  - Construct a prototype aperture and verify its specifications in a tank test or sea test using a controlled source.

	FY 2004	FY 2005	FY 2006	FY 2007
Jet Blast Deflector	0.000	3.400	1.000	0.000

(U) The Jet Blast Deflector program is an outgrowth of the DARPA structural materials program funded in PE 0602715E. The program will use multifunctional materials to construct a passively cooled jet blast deflection that increases reliability and meets weight reduction requirements for current and future classes of aircraft carriers. A Memorandum of Agreement has been signed with the Navy's PEO (Aircraft Carriers) that agrees to, based on a successful sub-scale concept demonstration by end of FY 2005, full scale demonstration of prototype panel performance at Naval Air Warfare Center, Aircraft Division Lakehurst and a use decision for CVN21.

(U) Program Plans:
- Demonstrate that multifunctional materials can reduce weight by over 50% and will save operations and support costs by 26%.
- Test and validate performance and savings.

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	FY 2004	FY 2005	FY 2006	FY 2007
Non-Linear Dynamics for ASW	0.000	0.000	2.500	3.000

(U) The field of nonlinear dynamics has matured sufficiently to allow applications to nonlinear and non-stationary signal processing problems. Nonlinear beamforming approaches will be applied to the Navy's Advanced Extended Echo Ranging (AEER) airborne Anti Submarine Warfare (ASW) concept to enhance the effectiveness of active acoustics in the littoral ASW environment by improving the ability to detect weak signals in the presence of noise, interference, and reverberation. This program will demonstrate that the nonlinear dynamics processing improves the minimum detectable signal level (MDL) performance of the Air Deployed Active Receiver (ADAR) system in a reverberation-limited environment. A nonlinear beamformer will be developed for the SSQ-101 ADAR sonobuoy based on arrays of coupled nonlinear oscillators implemented in analog VLSI demonstrating improved sidelobe performance. Significant technical challenges include array dynamic response, bandwidth response of the coherent source center frequency, synchronization to false targets, and increased main beam gain for weak signals.

(U) Program Plans:

- Develop system requirements for nonlinear ADAR beamformer.
- Develop analytical formulation of the nonlinear ADAR beamformer array dynamics.
- Develop high fidelity time series simulation for evaluating nonlinear beamformer performance.
- Develop quantitative assessment of potential improvement for realistic environments.
- Develop analog VLSI hardware of nonlinear oscillators.
- Develop prototype nonlinear beamformer and associated electronics compatible with ADAR sonobuoy.
- Demonstrate system performance in ADAR sonobuoy configuration using recorded data.

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	FY 2004	FY 2005	FY 2006	FY 2007
Reduced Size, Affordable Submarines	0.000	5.000	10.500	15.500

(U) Based on the results of the DARPA/Navy Submarine Design Study and concepts explored under the MUDS concept from this PE/Project, the Tango Bravo technology demonstration program will explore design options for a reduced-size submarine with equivalent capability as the VIRGINIA Class submarine. The implicit goal of this program is to reduce platform infrastructure and, ultimately, the cost of future design and production of submarines. Additionally, reduced platform infrastructure provides the opportunity for greater payload volume. Although this effort is focused on projects that are driven by projected submarine requirements, it is recognized that several of these developments will have applicability to multiple Navy platforms that share similar inherent infrastructure (e.g., hydraulics, torpedo handling/launch, and sonar). This program will be a collaborative effort to overcome selected technological barriers that are judged to have a significant impact on submarine platform infrastructure cost. DARPA and the Navy, under Memorandum of Agreement in September 2004, will jointly formulate technical objectives for critical technology demonstrations in: (1) propulsion concepts not constrained by a centerline shaft, (2) externally stowed and launched weapons (especially torpedoes), (3) conformal alternatives to the existing spherical sonar array, (4) technologies that eliminate or substantially simplify existing submarine hull, mechanical and electrical systems, and (5) automation to reduce crew workload for standard tasks. Several concepts will be explored with ultimately a 1/4 scale model being built and tested.

(U) Program Plans:

- Conduct a shaftless propulsion demonstration at an appropriate scale to validate key aspects of the concept such as system size and weight, propulsive efficiency, and acoustic and electromagnetic signatures, including predictive capability.
- Perform an integrated demonstration of the critical equipment required to provide external weapons launch at tactically useful speeds. Definition of the demonstration will include launch hydrodynamics and acoustics, as well as maintenance and health issues associated with prolonged weapon storage away from manned access.
- Conduct a demonstration to prove the critical technologies to show how a conformal alternative can provide the critical functionality of the spherical bow array on existing submarines.
- Develop and demonstrate concepts and technologies required to eliminate or substantially simplify existing shipboard systems (e.g., hydraulic/pneumatic vs. electrical actuation).

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– Develop and demonstrate automation approaches that provide equivalent or better performance with reduced manpower for activities that are currently personnel intensive (e.g., fire control party).

(U) Other Program Funding Summary Cost:

- Not Applicable.