RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)					DATE February 2006		
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development			R-1 ITEM NOMENCLATURE Network-Centric Warfare Technology PE 0603766E				
COST (In Millions)	FY 2005	FY2006	FY2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	118.538	134.944	174.276	178.032	170.066	172.066	173.066
Joint Warfare Systems NET-01	31.813	55.024	78.605	82.750	84.657	85.657	89.657
Maritime Systems NET-02	30.059	32.834	34.753	30.903	30.839	30.839	30.839
Classified NET-CLS	56.666	47.086	60.918	64.379	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 technologies 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 2005**	**FY 2006**	**FY 2007**
Previous President's Budget	121.613	136.899	176.855
Current Budget	118.538	134.944	174.276
Total Adjustments	-3.075	-1.955	-2.579
Congressional project reductions	-0.090	-1.955	
Congressional increases	0.000		
Reprogrammings	0.000		
SBIR/STTR transfer	-2.985		

(U) Change Summary Explanation:

FY 2005	Decrease reflects DOE transfer for P.L. 108-447 and the SBIR/STTR transfer.
FY 2006	Decrease reflects undistributed reductions for Section 8125 and the 1% reduction for Section 3801: Government-wide rescission.
FY 2007	Decrease reflects minor shifts in program pricing and phasing.

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Joint Warfare Systems NET-01	31.813	55.024	78.605	82.750	84.657	85.657	89.657

(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 leverage current and emerging network, robotic, and information technology and provide 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.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Network Command	15.085	15.520	15.216

(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

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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 transitioned to the Army Program Executive Office Command, Control, and Communications Tactical (PEO C3T) in January 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 has introduced 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 based on advancements made under the Command Post of the Future (CPOF) program and 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 will monitor and adapt to user-system interactions, user-user collaborations, and changes in the operational environment. MACE allows users to be distinguished by their military function – intelligence, maneuver, fires, security, logistics – and tailors displays and communication modes to those functions. The system will also utilize profiles of the users that contain information about career, previous deployments and information display preferences to make the system more adaptable. Finally, the technology scales the environment from dozens to hundreds of workstations operating over a diverse set of tactical communication networks.

- 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

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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. Technologies are planned to transition to the U.S. Army Distributed Common Ground Station.

- 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. Technologies are planned to transition to the U.S. Army Simulation, Training & Instrumentation Command.

(U) Program Plans:

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

– Multiuser, Adaptive Command Environment
  -- Collected data from field operations describing information flows, timing, and decision patterns.
  -- Identified 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.

– Network-Centric Situation Assessment
  -- Identify data fields available to a representative theater commander.

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-- 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 2005	FY 2006	FY 2007
Precision Urban Combat Systems (PUCS)	4.000	8.423	11.165

(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, and 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. Technologies are planned to transition to the U.S. Special Operations Command.

- The Robust, Persistent 3D Urban RSTA (reconnaissance, surveillance and target acquisition) program is providing 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 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 distributed 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 Networked Acoustic-Visual Imaging System (NAVIS) (formerly Head Mounted Alerting for Urban Operations) program will develop a networked weapon fire detection system using infrared sensor imagery fused with acoustic sensor information for precise localization of the source of weapon fire. The NAVIS system is a soldier-borne sensor array that moves with the dismounted unit, continually adapting to the dynamic threat situation in urban operations. The system exploits all available infrared and acoustic event data and correlates all observables from a multi-sensor, multi-node, networked array to minimize false alarms and maximize accuracy. The challenge of this initiative is to provide a moving networked sensor array, borne by dismounted warfighters, with near real-time visualization of the fused firing event data for immediate response and accurate pointing.

- 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.

- The Solar Blind UV Tagging, Tracking & Location (TTL) program will develop technologies and methodologies required to locate a vehicle in an urban environment. A compact and covert solar-blind Ultra Violet (UV) “tag” can be visually followed through non-Line-of-Sight (LOS) tracking by a UV camera. This program is critical to tracking vehicles containing persons of interest through a difficult visual tracking urban environment. Phase one of the project involves concept of operations development, modeling, and validation. Ground-based field tests will be performed with DayCor II UV cameras to assure strength of detection and non-LOS isolation of the tag. Following successful ground tests, the second phase involves procurement and integration of an airborne platform to validate concept of operations for aerial tracking of the source tags. The primary technical obstacles that must be overcome to develop the tracking

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mechanism are the development of a powerful enough UV source to facilitate detection through non-LOS scattering at a safe hovering altitude. The tag must be both small enough to be unnoticeable and big enough to support a battery supply for reasonable power life. In addition, this UV source must be detectable and distinguishable from other sources by the camera. The UV camera must be able to queue the observer and allow for reliable geo-tracking of a tag through joystick controls and visual detection. This capability will be transitioned to Air Force and Army Combatant commands for use in ground-based and low-altitude airborne reconnaissance platforms starting in FY 2008.

(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.

– 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.
  -- Conduct demonstration at a representative MOUT site.

– Networked, Acoustic-Visual Imaging Systems (NAVIS)
  -- Develop dynamic network sensor processing algorithms.
  -- Develop fusion emulator for post processing data analysis.
  -- Conduct testing and data collection under controlled motion conditions and various conditions.
  -- Develop brassboard processor with sensor and fusion processing algorithms.
  -- Conduct live-fire testing under controlled motion conditions in realistic urban conditions.
  -- Develop real-time fusion and visualization software.
  -- Design and develop a man-wearable NAVIS prototype.

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– 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.

– Solar Blind UV Tagging, Tracking & Location
  -- Develop conceptual design and CONOPS meeting objective system performance requirements.
  -- Ground-based demo verifying signal strength and non-LOS tracking.
  -- Develop airborne testbed and conduct flight demo.

	FY 2005	FY 2006	FY 2007
Effects Based Network Targeting	3.600	4.062	4.500

(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. Technologies are planned to transition to the U.S. Strategic Command.

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(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.

	FY 2005	FY 2006	FY 2007
Confirmatory Hunter Killer System	9.128	8.741	6.481

(U) The Confirmatory Hunter-Killer System program is developing a low-cost, expendable loitering weapon/unmanned air vehicle for deployment in urban environments. The objective is to provide localized surveillance against limited (one or two) specific targets. The vehicle employs two on-board electro-optic/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, time-critical targets, emerging targets, and threats to lines of communication and other delimited regions. The program enables suppression of targets emerging from underground or concealed facilities. The Confirmatory Hunter Killer System is planned for transition to the Army, at the conclusion of Phase II anticipated to be completed by the end of FY 2007.

(U) Program Plans:
- Characterized component capabilities (platform, sensor, and onboard automatic target tracking and data links).
- Developed and analyzed alternative designs, using high-fidelity simulation and analysis tools in a variety of joint mission contexts.
- Selected combinations of components that achieved the most effective system capabilities.
- Develop a brass-board platform with compact hand-launcher; verify sensor, automatic target tracking, 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 2005	FY 2006	FY 2007
Sensing and Patrolling Enablers Yielding Enhanced Security (SPEYES)	0.000	5.633	7.631

(U) The Sensing and Patrolling Enablers Yielding Enhanced Security (SPEYES) program provides technologies for Stability and Support Operations (SASO) to enhance the capabilities of our current ground forces in Iraq and Afghanistan. The first program phase evaluates and inserts mature advanced ground-based C3I technologies for three problem areas (Fixed Site Security, Patrolling, and Cordon & Search), seeking to effect a significant force-multiplier improvement through transformational Tactics, Techniques, and Procedures (TTPs). Key Component Technologies include: 1) WASP Micro UAV, 2) Eye Ball R1 Throwable Camera, 3) Leave Behind Intrusion Detection Sensor, 4) SPEYES Handheld PDA Device, and 5) Vehicle Weight Analysis Software and Video/EOD Underbody Sniffers. Later program phases will expand SPEYES technologies to develop a deeper understanding of team cooperation and culture in dynamic coalition and multi-national team settings. This work will focus on the development of two cultural advisors, one for the soldier on patrol and a second cultural advisor for command staff and strategic-level military personnel, which will incorporate extensive cultural knowledge for interacting with civilian government officials, military coalition partners and multinational teams. The technology is planned for transition to the Army and Marine Corps.

(U) Program Plans:

- Develop/procure prototypes of selected SPEYES technologies.
- Plan, conduct, and evaluate appropriate training events with selected Marine and Army deploying units to determine employment CONOPS.
- Following ruggedization of selected prototypes, provide deployable technology for movement to theater.
- Develop local and regional cultural databases and mappings of cultural dynamics of behavior.
- Develop and evaluate an information gathering and retrieval capability for patrolling soldiers.
- Evaluate system functions for both individual and staff level functions in culturally specific environments at the National Training Center.

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	FY 2005	FY 2006	FY 2007
Multi Dimensional Mobility Robot (MDMR)	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 2005	FY 2006	FY 2007
Network Centric Logistics	0.000	4.645	6.972

(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 feed forward 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

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stability, and (4) transport planning technology to enable unconventional commodity flows. Technologies are planned to transition to the U.S. Army and U.S. Transportation Command.

(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.

	FY 2005	FY 2006	FY 2007
Human-carried Explosive Detection Stand-off System (HEDSS)	0.000	0.000	3.000

(U) Insurgent and terrorist elements are increasingly relying on human carried explosives because they are nearly impossible to detect visibly. The goal of the Human-carried Explosive Detection Stand-off System (HEDSS) program is to develop a system that can rapidly identify human-carried explosives (HCEs) at a stand-off range between 50 and 150 meters. While alternative technologies exist for HCE detection, they necessitate close-in sensing, are expensive and require extended processing times. Successful development of a HEDSS with detection ranges of 50 – 150 m will provide reliable protection for deployed forces from suicide bombers by allowing enough time and space to interdict bombers before they cause maximum damage.

(U) Program Plans:
- Conduct proof-of-concept experiments and perform system level analysis designed to validate key technical assumptions and identify major system design parameters.
- Design components and system.
- Build and integrate system and conduct lab experimentation.
- Conduct extensive field testing of the system under realistic threat conditions.

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	FY 2005	FY 2006	FY 2007
Federated Object-level Exploitation (FOX)	0.000	(6.885)	10.400

(U) Federated Object-level Exploitation (FOX) thrust will provide a new set of geospatial intelligence products, continuously updated and maintained in a form that ensures their consistency across both product elements (digital elevation models, traditional maps, 3D structure models, census summaries, and directories) and spatial nodes (coarse resolution country data for economic analysis to fine resolution building data for platoon-level combat operations). Included programs will combine techniques including model-based image analysis (both object recognizers and change detectors), symbolic correlators (both temporal and spatial), and emerging cognitive methods to identify changes to objects, addresses, names, and functions of natural and man-made structures. These algorithms will be scaled to operate on data streams including full-motion video, ladar, text, and tabular data, in addition to conventional geospatial imagery. Federated algorithm architectures will be explored to achieve scalability through spatial, temporal and ontological partitioning. FOX technologies are planned for transition to the National Geospatial-Intelligence Agency. FOX transfers from PE 0603762E, project SEN-02 in FY 2007.

- The Auto Metadata Extractions effort will build a system to automatically (with no man-in-the-loop) extract metadata from 400 terabytes of multi-sensor all-source imagery, Moving Target Indicator (MTI) and signals per day. Extracted metadata will include both platform generated information (classical metadata) and algorithmically extracted features and internals. The extracted metadata will be (a) produced in a unified framework, and (b) sufficiently semantically rich to support both semantic information fusion and development of multi-dimensional predictive models. The system will provide all of the fundamental extracted data required for advanced exploitation technology development.

- The Exploitation Language Technology for GeoINT program will build a system to extract and linguistically confirm terms and labels of geographic significance from graphical, textual and audio sources. Develop the technology to associate and verify the extracted information against features extracted from imagery. Both extraction and association will be performed against and across multiple languages. Develop necessary database and query technology to support rapid access and search against the developed corpus. Develop necessary database and query technology to support a wide range of GeoINT specific concepts, e.g., feature classes, complex distance calculations, and boundaries.

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- The All Things Repository effort will develop a system capable of ingesting 400 terabytes of multi-sensor all-source imagery, Moving Target Indicator (MTI) and signals per day. Build a fully automated metadata and features extraction framework to process all incoming data. Develop the distributed very-large database technologies required to provide both the raw sensor data and extracted features data to a multi-level exploitation user community which consists of both human users and automated agents. Develop work-flow aware data transformation, data aggregation and data caching technologies which will rapidly provide the user with access to the correct subset of the data rapidly and at appropriate bandwidth.

(U) Program Plans:

– Auto Metadata Extractions
  -- Develop a unified processing infrastructure for the generation of metadata from all-source.
  -- Demonstrate a unified semantic representation of metadata generated from all-source.
  -- Demonstrate the collection/conversion of platform generated metadata into the unified representation.
  -- Demonstrate generation of metadata from all-source imagery into unified representation.
  -- Demonstrate generation of metadata from MTI into unified representation.
  -- Demonstrate generation of metadata from signals into unified representation.
  -- Demonstrate generation of metadata from fusion of prior metadata into unified representation.

– Exploitation Language Technology for GeoINT
  -- Demonstrate extraction of geographic terms, e.g., city names, and their association with geolocations from textual sources.
  -- Demonstrate extraction of geographic terms, e.g., street names, and their association with geolocations from graphical sources.
  -- Develop a multi-lingual ontology of geographic language.
  -- Demonstration extraction of geographic language from graphical, textual and audio sources.
  -- Demonstrate multi-lingual queries of geographic language from a large collection of extracted terms.

– All Things Repository
  -- Demonstrate a multi-source co-registered database over a village sized site.
  -- Demonstrate unified access in a single query to multiple spatial and temporal data types.
  -- Demonstrate incorporation of automated feature extraction into high volume data flow.

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-- Experimentally determine where data volume causes system failures.
-- Demonstrate solutions to very large data volume induced failures.
-- Demonstrate data selection and summarization based on prior work-flows and access.

	FY 2005	FY 2006	FY 2007
Acoustic Landmine Detection System	0.000	0.000	3.000

(U) The Acoustic Landmine Detection System will develop new acoustic and detection technologies to overcome deficiencies in locating landmines. These systems will include the use of highly directional sound sources to cause the mines to vibrate at sufficient amplitude to be detected with a wide field-of-view laser interferometer. This approach will provide a system with the high probability of detection and low false-alarm rate required to meet the needs of the warfighter. Initial efforts will include field measurements at a landmine detection research facility to determine the tradeoffs among various detection technologies. These experiments will determine the system performance capabilities needed to support troop advance rates >30km/hour in hostile terrain. The systems developed under this effort will be tested against a wide variety of mine types and soil properties to support operations under a wide range of conditions. Upon successful development of the initial and objective systems, the capabilities will be transitioned to the Army and Marine ground forces for the development and employment of operational systems starting in FY 2010.

(U) Program Plans:
- Develop conceptual system designs meeting objective system performance (e.g., scan rates commensurate with >30km/hr convoy speed).
- Perform risk reduction technology development for the acoustic source and vibrometric sensor.
- Conduct brassboard demo of prototype.
- Construct form factor prototype and verify performance.
- Transition systems technology to Army and Marines for incorporation into future force structures.

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(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Maritime Systems NET-02	30.059	32.834	34.753	30.903	30.839	30.839	30.839

(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 Tango Bravo (formerly Reduced Size, Affordable Submarines) technology demonstration program.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Mobile Undersea Distributed Systems (MUDS) Program	18.109	18.834	16.753

(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 investigated 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 was explored. This effort identified 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.

(U) The Persistent Ocean Surveillance program 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, ocean waves, solar energy, temperature differentials, etc.) for their power, miniature geolocation technologies, and technologies for sensor data storage, transmission, and intra-field communications. Persistent Ocean Surveillance-Station Keeping technology is planned for transition to the Navy 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 program seeks to develop an energy-dense air-independent underwater power source as a potential propulsion system for underwater vehicles. This program will optimize the design for a small combustor and develop the auxiliary power system components needed to control and sustain operations. In addition to the combustor, the aluminum fuel feed subsystem, aluminum-steam separator subsystem; and closed loop control subsystem will be designed, built, and tested and integrated with a turbine in order to successfully demonstrate a power system in a laboratory environment. The Aluminum Combustor technology is anticipated to transition to the Navy in FY 2008.

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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 speed and direction 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. The River Eye effort is anticipated to transition to the Navy and National Geospatial-Intelligence Agency in FY 2010.

(U) The ability of U.S. Navy submarines to maintain situation awareness and tactical advantage in shallow water is challenged by difficulty to safely deploy the highest-capability acoustic sensor, the long towed array. The Compact Aperture Ranging Passive Sonar (CARPS) effort explored the feasibility of a towed array capability in a compact hull or dome-mounted sonar aperture. CARPS sought to exploit non-acoustic shear waves induced in the material of a small aperture by external acoustic energy. The program evaluated 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
  - Assessed concepts employing swarms of undersea vehicles with acoustic and non-acoustic sensing modalities for detecting and tracking submarines with air-independent propulsion (AIP) systems.
  - Assessed performance of acoustic and electric field sensors on undersea gliders.

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- Persistent Ocean Surveillance
  - Explored the scientific/engineering issues associated with station keeping.
  - Demonstrated feasibility of using nanofluidic technology with moving magnets in linear generated configuration to harvest wave energy.
  - Characterized ferrofluidic material and developed electromagnetic models.
  - 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

  Generate capabilities and identify technologies of interest to include:
  - -- Technologies that allow dispersed, maneuvering forces to conduct network-enabled operations at extended distances from over the horizon.
  - -- Technologies to increase the warfighter's situational awareness.
  - -- Technologies to increase shared situational awareness among adjacent units as well as among higher and lower echelons of command.
  - -- Technologies to allow small units to apply joint precision fires.
  - -- Technologies to enhance the survivability and biology-oriented performance of the warfighter.
  - -- Technologies to enable the sustainment of widely dispersed units (squad to battalion-size) over extended periods.
  - -- Technologies to reduce the logistics burden of combat, combat support and combat service support forces, such as alternate fuels and power sources, reduced diameter weapons and liquid propellants.
  - -- Technologies to enhance the personal and collective mobility of ground forces.

- 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.

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- Design and fabricate the low Hp combustor, aluminum fuel feed subsystem, aluminum-steam separator subsystem; and closed loop control subsystem.
- Integrate and test the power system in the laboratory.

- River Eye
  - Assessed sensor modalities, and conducted field experiments in mixed estuary environments establishing proof of concept.
  - Conduct analysis on existing circulation models to determine model sensitivity to bathymetry, winds, and fresh water inflow.
  - Develop inverse model for extracting bathymetry from indirectly sensed currents.
  - 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)
  - Investigated the concept through analysis and simulation.

	FY 2005	FY 2006	FY 2007
Jet Blast Deflector	2.950	1.000	1.000

(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 was signed (January 2004) 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 2005	FY 2006	FY 2007
Non-Linear Dynamics for ASW	0.000	2.500	0.000

(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.

(U) Program Plans:
- Develop system requirements for the nonlinear Air Deployable Active Receiver (ADAR) beamformer.
- Develop analytical formulation of the nonlinear ADAR beamformer array dynamics.
- Develop high fidelity time series simulation data for evaluating nonlinear beamformer performance.
- Develop quantitative assessment of potential improvement for realistic environments.

	FY 2005	FY 2006	FY 2007
Tango Bravo (formerly known as Reduced Size, Affordable Submarines)	9.000	10.500	17.000

(U) Based on the results of the DARPA/Navy Submarine Design Study, the Tango Bravo technology demonstration (formerly known as the Reduced Size, Affordable Submarines) program is exploring design options for a reduced-size submarine with equivalent capability of 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. The program is 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 jointly formulated technical objectives for critical technology demonstrations in: (1) shaftless propulsion, (2) external weapons stowage and launch, (3) conformal alternatives to the existing spherical sonar array, (4) radical ship infrastructure reduction technologies that eliminate or substantially simplify hull, mechanical and electrical systems, and, (5) automated attack center technologies to reduce crew manning. The Tango Bravo program is anticipated to transition to the Navy in FY 2009.

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(U) A substantial challenge faced by the Navy submarine force is communications at speed and depth (CatSD). With the advent of network centric warfare, the submarine's evolving tactical missions require both timely transmission and receipt of tactical intelligence and operational directives. When mission effectiveness requires the submarine to operate below periscope depth, the challenge to communicate greatly affects the submarine's contributions to the operational commander. This program will develop an expendable communications device/system that would enable high bandwidth communications at tactically significant speeds and depths while minimizing probability of detection. It combines a propelled tow body with a hybrid, inflatable kite to hold an antenna aloft for extended periods. The tow body would be connected to the submarine by a cable tether, which supplies electrical power for tow body propulsion and communications signal amplification. The propelled tow body will be designed to deploy from the signal ejector of any U.S. submarine.

(U) Program Plans:

- Tango Bravo
  - Develop shaftless propulsion concepts and demonstrate required technologies at an appropriate scale to validate key aspects such as system size and weight, propulsive efficiency, and acoustic and electromagnetic signatures, including predictive capability.
  - Develop external weapons stowage and launch concepts and conduct an integrated demonstration of the critical technologies required to meet launch hydrodynamics requirements while providing a safe stowage environment for a Mk48 ADCAP torpedo outside the pressure hull.
  - Investigate maintenance and health issues associated with prolonged weapon stowage away from manned access.
  - Analyze modeling to evaluate acoustic and shock performance requirements.
  - Develop and demonstrate a radical ship infrastructure reduction concept that relies on electric actuation of the rudder and stern planes instead of traditional hydraulic- mechanical movement of the ship's control surfaces.
  - Demonstrate that employment of the proposed concept in an "X" (vice cruciform) configuration of the stern planes and rudder provides sufficient control authority such that the retractable bow plane system would not be required.

- Expendable Communications at Speed and Depth (CatSD) System
  - Develop guidance and control technology for propelled, inverted tow body towing.
  - Develop hybrid balloon kite antenna sub-system.
  - Design and procure tether cable system.

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– Conduct towed and ejected demonstrations.

(U) Other Program Funding Summary Cost:

- Not Applicable.