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APPROPRIATION/BUDGET ACTIVITY 0400 - Research, Development, Test & Evaluation, Defense-Wide/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603766E NETWORK-CENTRIC WARFARE TECHNOLOGY

COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
Total Program Element	132.962	154.015	135.941						Continuing	Continuing
NET-01: JOINT WARFARE SYSTEMS	55.056	44.003	40.954						Continuing	Continuing
NET-02: MARITIME SYSTEMS	25.066	30.053	28.757						Continuing	Continuing
NET-CLS: CLASSIFIED	52.840	79.959	66.230						Continuing	Continuing

A. Mission Description and Budget Item Justification

(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 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 collocated, 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.

(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.

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B. Program Change Summary ($ in Millions)

	FY 2008	**FY 2009**	**FY 2010**	**FY 2011**
Previous President's Budget	150.677	156.733	220.952	
Current BES/President's Budget	132.962	154.015	135.941	
Total Adjustments	-17.715	-2.718	-85.011	
Congressional Program Reductions	0.000	-2.718		
Congressional Rescissions	0.000	0.000		
Total Congressional Increases	0.000	0.000		
Total Reprogrammings	-13.590	0.000		
SBIR/STTR Transfer	-4.125	0.000		
TotalOtherAdjustments			-85.011	

Change Summary Explanation

FY 2008
Decrease reflects the OMNIBUS and below threshold reprogrammings, and the SBIR/STTR transfer.

FY 2009
Decrease reflects the reductions for Section 8101 Economic Assumptions and reduction to proposed new starts.

FY 2010
Decrease reflects completion of Joint Warfare Systems programs, rephasing of the Tango Bravo quarter-scale submarine prototype, and repricing of other Maritime and Classified programs.

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COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
NET-01: JOINT WARFARE SYSTEMS	55.056	44.003	40.954						Continuing	Continuing

A. Mission Description and Budget Item Justification

(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 increased capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents using 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 co-located, 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 and tools, which acquire targets of opportunity and cue network-based analysis of likely enemy operations thus maximizing the effectiveness of ground forces in stability and support operations.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Geospatial Exploitation (GEO)*	10.062	4.000	4.000	
*Formerly Federated Object-level eXploitation (FOX).				
(U) The Geospatial Exploitation (GEO) thrust will provide a new set of geospatial intelligence (GEOINT) products, continuously updated and maintained in a form that ensures their consistency across both product elements (digital elevation models, traditional maps, 3-D 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). Techniques of interest include 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 human-made structures. These algorithms will be scaled to operate on data streams including				

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
full-motion video, Laser Identification Detection and Ranging (LIDAR), multi- and hyper-spectral, synthetic aperture radar (SAR), and Geographic Information Systems (GIS) in addition to conventional electro-optical (EO) geospatial imagery. GEO algorithm architectures will be explored to achieve scalability through spatial, temporal and ontological partitioning. GEO technologies are planned for transition to the National Geospatial-Intelligence Agency (NGA). • The Urban Reasoning and Geospatial Exploitation Technology (URGENT) program (formerly Auto Metadata Extractions) will develop a 3-D urban object recognition and exploitation system that enables advanced mission planning and situation analysis capabilities for the warfighter operating in urban environments. URGENT will create techniques for the rapid exploitation of EO and LIDAR sensor data at the city scale to recognize urban objects down to the soldier scale. URGENT will apply image processing technology to geospatially registered 2-D/3-D data collected from airborne and terrestrial sources, yielding precise annotations for the objects in an urban area. URGENT will also develop a 3-D reasoning engine to query object shapes, locations, and classifications for advanced geospatial exploitation capabilities. • 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. The program will 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. A major effort will be made to develop necessary database and query technology to support a wide range of GeoINT specific concepts, e.g., feature classes, complex distance calculations, and boundaries. • The Geospatial Representation Integrated Dataspace (GRID) program (formerly All Things Repository) will develop an automated geospatial data fusion, modeling, and dissemination system from national assets for the tactical warfighter. Geospatial registration algorithms will automatically fuse geospatial data from multiple sources including EO, LIDAR, SAR, and hyperspectral - and encode the fused data as a temporally indexed volumetric model that drastically reduces geospatial data storage requirements while enhancing image quality. Updates will propagate to the model using a compressed geospatial data format capable of reaching the warfighter even with the bandwidth constraints of tactical networks.				

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

FY 2008 Accomplishments:

Urban Reasoning and Geospatial Exploitation Technology (URGENT)
- Demonstrated automated object recognition capability on fused EO and LIDAR data from aerial and terrestrial urban sources.
- Evaluated performance of automated object recognition in comparison with the performance of human geospatial analysts.

Exploitation Language Technology for GeoINT
- Performed preliminary design review of the GeoINT prototype.

Geospatial Representation Integrated Dataspace (GRID)
- Developed a new method to represent 3-D data that reduces the geospatial error of each source image when registered with a LIDAR foundation and leads to very high compression ratios in data storage without impacting a test application.

FY 2009 Plans:

Urban Reasoning and Geospatial Exploitation Technology (URGENT)
- Demonstrate automated object recognition capability on fused EO and LIDAR data from aerial and terrestrial urban sources.
- Evaluate speed and accuracy of performance of automated object recognition in comparison with the performance of human geospatial analysts.
- Develop capability for rapid retraining on one or more new geospatial areas and object classes.

Exploitation Language Technology for GeoINT
- Demonstrate dynamic extraction of urban geospatial information from available documents.

Geospatial Representation Integrated Dataspace (GRID)
- Demonstrate volumetric encoding of LIDAR, electo-optical and hyper-spectral data from national assets showing a reduction in data storage relative to the raw data without impacting performance.
- Develop ability to detect changes at the object level in multi-modal geospatial data.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Evaluate efficiency of geospatial data encoding and change detection with comparison to geospatial data derived from national assets. *FY 2010 Plans:* Urban Reasoning and Geospatial Exploitation Technology (URGENT) - Transition selected object recognition technology to a military geospatial analysis environment. - Develop methods for automated geospatial reasoning over the shapes, locations, and classifications of objects in the urban terrain. - Evaluate automated geospatial reasoning in urban mission planning in comparison with the performance of human mission planners. Geospatial Representation Integrated Dataspace (GRID) - Demonstrate the volumetric encoding of non-optical (e.g., SAR) data with optical data. - Increase the compression ratio of volumetric data compared to raw geospatial source data. - Develop the ability to plan paths and analyze road network trafficability through complex urban terrain using fused geospatial data. - Develop the ability to propagate changes to the dataspace throughout a distributed system.				
Network Command (U) Network Command leverages recent advances in network computing, simulation, and visualization to dramatically improve collaboration among physically separate command posts and lower echelons. Network Command enables warfighters to share situation information and exploited data from the area of responsibility, develop coordinated battle plans, generate and compare alternate courses of action, and assess likely outcomes, without conventional group briefings. Network Command also enables warfighters to prepare for joint missions using high-fidelity, mixed-reality combat simulation and visualization technologies. • 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	6.000	3.000	2.500	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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, and 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. Technologies are planned to transition to the U.S. Army.				

• The Joint Mission Rehearsal program integrates high-fidelity, mixed-reality combat simulations with situation assessment and planning tools. The objective is to allow rehearsal of joint missions, prior to actual engagements. The visualization permits the warfighter to interact with both reality and the simulation simultaneously in a manner consistent with their anticipated role in the mission. 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, United States Special Operations Command (USSOCOM), and the Marine Corps Combat Development Command (MCCDC).

FY 2008 Accomplishments:
  Network-Centric Situation Assessment
  - Evaluated technologies using real-world data.

  Joint Mission Rehearsal
  - Evaluated technologies for insertion of avatars into a Helmet Mounted Display.

FY 2009 Plans:
  Network-Centric Situation Assessment
  - Complete system design and analysis.

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Joint Mission Rehearsal - Evaluate simulation technology for use in Army/Marine tactical scenarios. - Evaluate technology for use of synthetic Opposition Forces (OPFOR) within the real world-training environment. *FY 2010 Plans:* Joint Mission Rehearsal - Design a system for use in Platoon level mission rehearsal and planning. - Demonstrate in a simulated urban training environment with presentation of synthetic opposition forces (OPFOR).				
Mobile Intelligent Sensors (MIS)* *Previously part of Precision Urban Combat Systems. (U) The Mobile Intelligent Sensors (MIS) program (formerly Smart Dust Sensor Networks Applied to Urban Area Operations and Exploiting Vibrations to Monitor Activities in Building) and the Remote Detection of Suspicious Vehicles (RDSV) program are developing advanced sensor, exploitation, networking, and battle management capabilities for joint dismounted forces. There is particular interest in exploiting new legged, wheeled, and tracked robots to create "robot-enabled sensors" that are capable of sensing, moving, and self-organizing into a viable network for reliable data exfiltration. The nodes will have a sufficient level of embedded intelligence so that they can identify, learn, adapt, and traverse through or under small openings and circumnavigate barriers larger than themselves, yet be capable of carrying an operationally-meaningful day/night sensor payload. Envisioned payloads include EO/IR for day/night imaging and video surveillance/monitoring and acoustic/vibration sensing to obtain information such as foot and vehicular traffic, operation of mechanical systems, gunfire, excavation activities, etc. Technologies are planned to transition to the U.S. Army, U.S. Special Operations Command, and the U.S. Marine Corps.	6.000	2.000	2.000	

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
FY 2008 Accomplishments: Mobile Intelligent Sensors (MIS) - Identified/prioritized critical information requirements from networked, mobile intelligent sensors in an urban environment to support small tactical units and methods for information fusion/presentation. - Evaluated candidate sensor technologies and algorithms. Remote Detection of Suspicious Vehicles (RDSV) - Conducted three successful realistic military field evaluations, including a harsh desert setting. - Successfully detected human footsteps and vehicles in the desert environment. - Showed extended range capability in urban and rural environments. - Demonstrated successful operation in environments with high RF interference. - Initiated transition experiment planning with military services. *FY 2009 Plans:* Mobile Intelligent Sensors (MIS) - Create system definition, concept of operations, and operational scenarios. - Develop payload size, weight, and power requirements (SWAP) and assess the feasibility of alternative approaches. - Define signal processing requirements and identify algorithmic approaches. - Develop technologies to separate targets from background. - Develop and demonstrate algorithms for accurate geolocation of targets and clutter within buildings. - Collect data for offline performance analysis. Remote Detection of Suspicious Vehicles (RDSV) - Execute transition experiments and system development of field deployable prototypes with the U.S. Army, the U.S. Marine Corps, and other Agencies. *FY 2010 Plans:* Mobile Intelligent Sensors (MIS) - Develop sensors meeting SWAP requirements.				

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Implement algorithms and integrate a prototype signal processor.				
Seismic/Acoustic Vibration Imaging (SAVI) (U) The Seismic/Acoustic Vibration Imaging (SAVI) program will develop the capability to locate both near-surface tunnels and landmines with active seismic and acoustic sources. These systems will employ well characterized seismic and acoustic sources to stimulate the targets of interest from a remote platform. The interaction of the near surface seismic waves with tunnels and other objects will be observed with a multi-pixel laser interferometer system and used to assess the depth and extent of the targets in the midst of natural and man-made clutter. Similarly, focused acoustic sources will be employed to remotely stimulate plastic or metal antipersonnel and antitank mines. A laser interferometer system will be used to detect the resonant characteristics of the mines to discriminate against natural sources of clutter. The systems developed under this effort will be tested against a wide variety of soil types and environments 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 2011. *FY 2008 Accomplishments:* - Completed the preliminary reviews for the scalable system meeting the initial sensitivity and search rate objectives. - Initiated and demonstrated the technologies required for the laser interferometer system, including the sources and sensors, as well as the mobile seismic and directional acoustic sources. - Completed the development of operationally relevant test scenarios for scalable system demonstration. - Completed an outdoor demonstration of the acoustic landmine detection source and active seismic tunnel detection source meeting desired objectives. *FY 2009 Plans:* - Complete the development of the component technologies required by the scalable system demonstration. - Complete the development of high speed data processing capability to support realtime detection of buried landmines.	12.000	16.618	7.954	

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate scalable system integration for mobile detection demonstration. - Initiate the development of the scalable brassboard system for mobile operations. *FY 2010 Plans:* - Complete scalable system integration for mobile buried landmine and near surface tunnel. - Complete scalable system outdoor demonstration of acoustic landmine hunting and seismic tunnel testing. - Initiate scaled system development to improve coverage rate and standoff distance.				
Multipath Exploitation Radar (MER) (U) The Multipath Exploitation Radar (MER) program will address radar deficiencies in urban operations: limited line of sight due to urban structures and excessive confusers due to multipath reflections. This program will exploit multipath bounces to detect and track moving targets within urban canyons, and extend the area coverage rate of airborne sensors by a factor of ten or more over physical line-of-sight limits. If successful, the urban coverage improvement will make it cost effective to consider airborne surveillance of an area the size of a large metropolitan area with a handful of airborne sensors. This capability will facilitate both manned and unmanned airborne Intelligence, Surveillance and Reconnaissance (ISR) and is planned to transition to the Air Force and Army in 2010. *FY 2008 Accomplishments:* - Developed component requirements for multi-path urban collection. *FY 2009 Plans:* - Collect representative field data in urban environment using COTS radar for use in system design and testing. - Initiate system hardware and software design. - Develop urban tracking algorithms exploiting urban multipath return. - Document algorithm performance against urban field data. *FY 2010 Plans:* - Demonstrate improvement in urban tracking using multipath radar.	4.000	5.185	4.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Develop persistent wide-area surveillance architecture for large metropolitan areas.				

Human-carried Explosive Detection Stand-off System (HEDSS)
 	
(U) Insurgent and terrorist elements are increasingly relying on human carried explosives because they are nearly impossible to visibly detect. The goal of the Human-carried Explosive Detection Stand-off System (HEDSS) program is to develop a system that can rapidly and automatically identify human-carried explosives (HCEs) at a stand-off range of up to 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 up to 150 meters will provide reliable protection for deployed forces from suicide bombers by allowing enough time and space to interdict bombers before they cause maximum damage. The technology is planned for transition to the Army, Air Force and Marines.
 	
FY 2008 Accomplishments:
  - Designed and developed data collection system.
  - Conducted extensive data collection and analysis.
  - Developed algorithms and assessed system performance.
 	
FY 2009 Plans:
  - Develop preliminary design of demonstration system including analysis to achieve low cost production.
  - Perform detailed design of demonstration prototype.
 	
FY 2010 Plans:
  - Conduct extensive field testing and performance analysis.
	5.000	6.200	3.500	

Multi Dimensional Mobility Robot (MDMR) (U) The Multi Dimensional Mobility Robot (MDMR) program will investigate concepts using serpentine mobility to achieve new ground robot capabilities for search and rescue applications. The MDMR system will navigate complex urban terrain and provide the operator with real time images of its environment. Examples of the capability include: overcoming obstacles that are a significant fraction of its length,	5.000	1.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
crossing slippery surfaces, ascending poles, climbing steep slopes, and optically sensing its immediate surroundings. 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. The technology is planned for transition to SOCOM. *FY 2008 Accomplishments:* - Developed smaller, more maneuverable serpentine platform. - Developed and tested tele-operation control. - Developed and tested sensors for integration onto the serpentine platform. - Performed rigorous testing to characterize system performance. *FY 2009 Plans:* - Demonstrate field capable performance.				
Network Targeting* *Formerly Effects Based Network Targeting. (U) The Network Targeting program will develop advanced capabilities for a specified emitter density, operating environment, RF signal location accuracy, probability of correct RF signal identification and probability of false alarm. Each phase will progressively mature the design and technologies required to validate the ability to achieve system performance goals and move incrementally toward an operational system. *FY 2008 Accomplishments:* - Designed tools to analyze single networks. *FY 2009 Plans:* - Perform system design. - Develop components and software for a system.	2.794	3.000	9.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Conduct performance validation via laboratory demonstrations and demonstrations in a controlled operational environment. *FY 2010 Plans:* - Demonstrate real-time processing on brassboard hardware. - Conduct performance validation via demonstrations in a higher-complexity operational environment.				
Legged Squad Support System (LS3) (U) The Legged Squad Support System (LS3) program will explore the development of a mission-relevant quadruped platform scaled to unburden the infantry squad and hence unburden the soldier. Soldiers in current operations carry upwards of 50lbs of equipment, and in some cases over 100lbs, for long distances and in terrain not always accessible by wheeled platforms that support infantry. As a result, the soldier's combat effectiveness can be compromised. The LS3 program will design and develop prototypes capable of carrying 400lbs of payload for 20 miles in 24 hours, negotiating terrain and at endurance levels expected of typical squad maneuvers. LS3 will leverage technical breakthroughs of prior biologically inspired legged platform development efforts. It will develop system designs to the scale and performance adequate for infantry squad mission applications, focusing on platform, control, and human-machine interaction capabilities, as well as secondary design considerations, such as acoustic signature. Multiple technical approaches will be explored, including electromechanical and hydraulic methods of legged actuation. Anticipated service users include the Army, Marines and Special Forces. *FY 2009 Plans:* - Develop, analyze and assess preliminary designs to achieve a system capable of twenty miles of endurance in a twenty-four hour (unrefueled) period, carrying a 400lb payload. - Simulate gait selection, execution and transitioning. - Build subsystems that prove design validity. *FY 2010 Plans:* - Model foot placement, stability against disturbances, and self-righting. - Conduct subsystems testing and results analysis.	0.000	3.000	8.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete critical design review and integration plan, and initiate demonstration system fabrication.				

Urban Ops Hopper
 	
(U) The Urban Ops Hopper program developed a semi-autonomous hybrid hopping/articulated wheeled robotic platform that could adapt to the urban environment in real-time and provide both surgical lethality and/or Intelligence, Surveillance, and Reconnaissance (ISR) to any point of the urban jungle while remaining lightweight, small and expendable to minimize the burden on the soldier. In general, small robots or unmanned ground vehicles (UGV) are severely limited by obstacle negotiation capability. The demonstrated hopping capability allows small UGVs to overcome obstacles 40x-60x their own size. Hopping will extend robot navigation to six degrees-of-freedom situational location and mapping. Hopping mobility can be shown to be five times more efficient than hovering for obstacles at heights less than or equal to ten meters. The proposed hopping robot would be truly multi-functional in that it will negotiate all aspects of the urban battlefield to deliver ISR and/or lethal payloads to non-line-of-sight targets with precision. The articulated wheel design allows the robot to negotiate short-range obstacles for precision placement in difficult terrain. This program is planned to transition to Special Operation Forces.
 	
FY 2008 Accomplishments:
  - Developed 3-D ISR obstacle detection, classification, and mapping tools for an unknown environment.
  - Demonstrated autonomous navigation in an urban environment using upgraded mechanical and sensor suite.
  - Developed precision hopping through restricted pathways to include windows and stairwells.
  - Demonstrated precision hopping using upgraded mechanical articulated wheel design.
  - Evaluated technologies in various Military Operations on Urban Terrain (MOUT) facilities.
	4.200	0.000	0.000	

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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E. Performance Metrics

   Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

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APPROPRIATION/BUDGET ACTIVITY 0400 - Research, Development, Test & Evaluation, Defense-Wide/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603766E NETWORK-CENTRIC WARFARE TECHNOLOGY	PROJECT NUMBER NET-02

COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
NET-02: MARITIME SYSTEMS	25.066	30.053	28.757						Continuing	Continuing

A. Mission Description and Budget Item Justification

(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.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Persistent Ocean Surveillance (POS) (U) The Persistent Ocean Surveillance (POS) program combines geolocation techniques such as the global positioning system with station keeping and intra-sensor communication technologies to provide long-term 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 have been 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. The Renewal At-Sea Power program focuses on efficient energy capture from the environment in order to achieve capability for fully renewable power at sea. Technology from this program will be available for transition to the U.S. Navy. *FY 2008 Accomplishments:* - Conducted two at sea tests with integrated station keeping technologies and energy harvesting technologies.	3.463	3.250	2.000	

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

- Coordinated with Navy and identified high interest payload for long endurance demonstration of energy harvesting and station keeping technologies.
 	
FY 2009 Plans:
  - Conduct design study of efficient energy capture for long endurance capability.
  - Incorporate additional technologies to improve energy capture.
  - Develop computer simulation models.
 	
FY 2010 Plans:
  - Build instrumented platform to test improved endurance and survivability in high sea conditions.
  - Conduct at-sea testing to validate performance of technologies and system models.				

Aluminum Combustor
 	
(U) The Aluminum Combustor program developed technologies to enable an energy-dense air-independent underwater power source to be used as a propulsion system for future naval undersea warfare systems. This program sought to optimize the design for a small aluminum combustor, silane fuel treatment process, and developed 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 was designed, built, and integrated with a turbine in order to successfully demonstrate a power system in a laboratory environment.
 	
FY 2008 Accomplishments:
  - Optimized the fuel treatment protocol to prevent agglomeration and the formation of slag in the aluminum combustor.
  - Investigated novel naval applications for aluminum combustor power system.
	1.359	0.000	0.000	

River Eye (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 determining objective	3.584	3.082	2.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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. *FY 2008 Accomplishments:* - Demonstrated the feasibility of using an inverse circulation model to calculate the bathymetry given currents as an input. - Conducted two instrumented data collections of currents in a new environment/location and evaluated performance. *FY 2009 Plans:* - Continue development of the inverse model for extracting bathymetry from indirectly sensed currents. - Refine and tune algorithms for extracting circulation currents and bathymetry in more complex environments. *FY 2010 Plans:* - Improve the automation of the current extraction algorithms and inverse model to handle clouds and moving objects in the time series data.				
Tango Bravo (U) Based on the results of the DARPA/Navy Submarine Design Study, the Tango Bravo technology demonstration program is exploring design options for a reduced-size submarine with equivalent capability	16.660	15.721	9.257	

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B. Accomplishments/Planned Program ($ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
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 and infrastructure cost. DARPA and the Navy, under a 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. (U) Following success of shaftless propulsion technologies demonstrated in the Tango Bravo program, DARPA and the U.S. Navy will design, build, and test a large scale Submarine Shaftless Stern Demonstrator (S3D) to characterize and mitigate risks associated with ship integration into a next generation submarine propulsion option. The S3D will be built to the minimum scale necessary to extrapolate hydrodynamics, powering, and acoustics to full-scale performance. The most cost effective technical approach to developing the demonstrator design will be considered, including the modification of existing large-scale submarines. Elements of the Tango Bravo program will begin transition to the Navy in FY 2009, with full transition anticipated at the conclusion of the Submarine Shaftless Stern Demonstration (S3D) program in FY 2013. *FY 2008 Accomplishments:* - Completed shaftless propulsion component fabrication (motor propulsor, duct, and structure) and component testing (electrical motor characteristics, motor drive and motor controller). - Completed the propulsion plant cost model to demonstrate the Shaftless Propulsion concept reduces submarine construction costs. - Completed analysis and evaluation of Shaftless Propulsion acoustic performance, including investigation of risk reduction technical solution. - Commenced concept studies to determine the feasibility of integrating the Shaftless Propulsion project design into a submarine design concept. - Completed the External Weapons Stowage and Launch project by conducting full-scale, test depth, weapons launch testing.					

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Conducted full-scale external weapon submarine load/reload demonstration. - Completed Radical Ship Infrastructure Reduction project electric actuator bearing shock tests and commenced electric actuator dynamic load testing representative of maximum submarine operational loads and environmental conditions (seawater, test depth, silt). - Assessed programmatic and technical trade-offs to determine the optimum large-scale platform for S3D. - Commenced Shaftless Propulsion technical risk reduction tasks required prior to commencing S3D detailed design work. *FY 2009 Plans:* - Complete Shaftless Propulsion demonstrator assembly. - Complete Shaftless Propulsion integrated system testing (in-air, full load motor testing and Large Cavitation Channel acoustic testing). - Conclude testing of the electric actuator, including approximately one million full cycles of the actuator under representative at-sea dynamic loadings and pressures, completing the Radical Ship Infrastructure Reduction project. - Complete concept studies for S3D. - Complete Shaftless Propulsion technical risk reduction tasks on S3D. - Perform design studies and computational analysis to establish critical design parameters for S3D. - Prepare Request for Proposals (RFP) for S3D contract requirements. *FY 2010 Plans:* - Complete Shaftless Propulsion in-water endurance testing, thus concluding the Shaftless Propulsion project and Tango Bravo program. - Commence S3D propulsor detail design. - Commence S3D large-scale platform detail design.				
Maritime Persistent Surveillance and Awareness (MPSA)* *Formerly Sea Shield.	0.000	3.000	3.000	

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
(U) The Maritime Persistent Surveillance and Awareness (MPSA) program will develop an extensible battle management automation capability to provide persistent surveillance and situational awareness to protect naval forces against overwhelming threats. MPSA will use layered and distributed sensing and add data from all sources for the non-traditional areas of infrastructure, socio-political developments and economic indicators. These systems will enable timely and coordinated decision-making and vastly improved situational awareness under uncertainty for naval commanders. MPSA will enable intelligent deployment of sensors and network infrastructures, to protect sea-based assets, through effective cross-platform and multi-mission fusion and resource management with focus on stand-off and elusive threats. Automated tracking with intelligent fusion and classification, and assimilation of non-traditional information sets are of particular interest. This will require bringing additional processing power to bear, allowing implementation of complex processing algorithms. MPSA will also enable the decoupling of intelligence, surveillance, and reconnaissance/defense missions from offensive missions, improving the power projection capability of the deployed force. MPSA will depart from previous approaches in assessing the operational environment in that it will not rely solely upon military indicators, but will also expand understanding to include national infrastructure, socio-political, and economic indicators to better assess trends and threat development. *FY 2009 Plans:* - Develop technologies and system concepts for detection, classification, localization, tracking and optimized engagement of maritime targets. - Develop techniques to assimilate and process data from all sources to detect changes in national infrastructure, socio-political climate and economic indicators that could affect adversary military capacity and capabilities. *FY 2010 Plans:* - Assess effectiveness of component technologies through modeling and simulation. - Implement the techniques for assimilation and processing of classified and open source data to detect militarily relevant changes in a nation's physical infrastructure, socio-political climate and economic indicators. - Apply advanced human-computer interaction technology to optimize human/machine performance for the naval commander.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Blue Laser for Submarine Laser Communications (SLC)	0.000	5.000	10.000	
(U) The Blue Laser for Submarine Laser Communications (SLC) program was funded as the High Bandwidth Maritime Communications program in Budget Activity 2 (PE 0602702E) in FY 2009, but its applications focus made its funding more appropriate for Budget Activity 3. The program will develop the critical laser technology necessary to support the requirements for non-acoustic Anti-Submarine Warfare (ASW), mine detection, and submarine laser communication. SLC and non-acoustic ASW programs are intended to develop the world's first wall-plug efficient laser that operates both at an optimum water transmission band of open ocean water and at the wavelength of a Cesium Atomic Line Filter. There is a pressing need for improved ASW capabilities in the current operating environment, particularly in shallow water (above the thermocline) and littoral areas of operations. This laser has the potential to improve the detection depth of a non-acoustic anti-submarine warfare lidar system by a significant factor resulting in improved submarine communications. The Blue Laser technology is planned for transition to the Navy. *FY 2009 Plans:* - Design, build and test a power amplifier module to verify performance optically and thermally at high power. *FY 2010 Plans:* - Complete detailed design of flight brassboard transmitter. - Complete optical, mechanical and electrical designs. - Build and test optical, mechanical and electrical subassemblies for integration into the brassboard transmitter. - Commence building, integration, and testing of amplifier modules into a full power output subsystem.				
Thermal Management System for Ship Decks (TMD)	0.000	0.000	2.500	
(U) It is anticipated that the high engine exhaust temperatures from the next generation of Vertical Take Off and Landing (VTOL) aircraft deployed on navy ships will dramatically reduce the life of both the deck structure and the non-skid. The Thermal Management System for Ship Decks (TMD) will address this problem by demonstrating a heat distribution system with an integrated thermally stable non-skid				

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B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
coating. Upon satisfactory completion of the development and certification of the design, the TMD will be transitioned to the Navy for integration into amphibious assault ships. *FY 2010 Plans:* - Develop and construct scaled modular passively cooled thermal management system.				

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

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COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
NET-CLS: CLASSIFIED	52.840	79.959	66.230						Continuing	Continuing

A. Mission Description and Budget Item Justification
  This project funds Classified DARPA Programs. Details of this submission are classified.

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

Classified DARPA Program
 	
This project funds Classified DARPA Programs. Details of this submission are classified.
 	
FY 2008 Accomplishments:
  Details will be provided under separate cover.
 	
FY 2009 Plans:
  Details will be provided under separate cover.
 	
FY 2010 Plans:
  Details will be provided under separate cover.
	52.840	79.959	66.230	

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Details will be provided under separate cover.