RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)					DATE: February 2006		
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA2 Applied Research			R-1 ITEM NOMENCLATURE: Tactical Technology; PE 0602702E				
COST (In Millions)	FY 2005	FY2006	FY2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	316.673	346.076	383.680	448.165	493.591	509.935	476.565
Naval Warfare Technology TT-03	41.295	52.344	38.497	31.443	30.190	30.190	30.190
Advanced Land Systems Technology TT-04	64.065	71.306	74.299	99.927	116.365	122.279	129.109
Advanced Tactical Technology TT-06	107.096	97.375	111.706	115.074	125.256	125.256	125.256
Aeronautics Technology TT-07	47.876	58.290	78.027	84.462	100.452	105.752	80.752
Network Centric Enabling Technology TT-13	56.341	66.761	81.151	117.259	121.328	126.458	111.258

(U) Mission Description:

(U) This program element is budgeted in the Applied Research Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The Tactical Technology program element funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Advanced Tactical Technology, Aeronautics Technology and Network Centric Enabling technologies.

(U) The Naval Warfare Technology project develops advanced enabling technologies for a broad range of naval requirements. The Friction Drag Reduction program will develop friction drag reduction technologies for surface ships and submersibles. The Hypersonics Flight Demonstration program is a joint Navy/DARPA effort that will develop and demonstrate advanced technologies for hypersonic flight. The High Efficiency Distributed Lighting program will change the fundamental design for lighting systems, resulting in increased warship maintainability and survivability. The Surface Warfare Automated Shiphandling program will develop technologies to increase survivability and operational effectiveness of small and medium surface vessels in rough seas. New areas to be investigated are ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations and predictive tools for small craft hydrodynamic design.

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(U) The Advanced Land Systems Technology project is developing technologies for enhancing the U.S. military's effectiveness and survivability in operations ranging from operations against traditional threats and emerging irregular threats that can employ disruptive or catastrophic capabilities. The Networking Extreme Environments program will address integration of ultra wide band communications and sensor systems. The Novel Sensors for Force Protection program is developing technologies to protect U.S. warfighters such as using a variety of fused multi-spectral techniques to identify the presence of people inside of buildings and chemical sensors capable of providing an advanced warning of the presence of enemy troops. The Dynamic Optical Tags program will develop new tagging, tracking and location capabilities for U.S. forces. The Guided Projectiles program will develop highly maneuverable gun-launched projectiles for defense against ground and air threats. The Compact Military Engines program will apply innovative ideas for engine design to produce performance gains not obtainable by further refinement of conventional designs. Two new initiatives, Sweeper and Maneuver and Control on the Urban Battlefield will address technologies for building clearing robots and access tools for use in tactical urban operations.

(U) The Advanced Tactical Technology project is exploring the application of compact and solid state lasers; high performance computational algorithms to enhance signal processing, target recognition and tracking, electromagnetic propagation, and processing of advanced materials and microelectronics; precision optics components for critical DoD applications; aerospace electronic warfare systems; new tactical systems for enhanced air vehicle survivability, advanced airbreathing weapons, and enabling technologies for advanced space systems; and a Training Superiority program that will create revolutionary new training techniques.

(U) The Aeronautics Technology project explores technologies to reduce costs associated with advanced aeronautical systems and provide revolutionary new capabilities for current and projected military mission requirements. This project funds development of micro adaptive flow control technologies; small-scale propulsion system concepts; and a high-strength, low structural weight airlift vehicle designed to control its buoyant lift independently of off-board ballast. New areas to be investigated are reusable hypersonic vehicles; novel helicopter blade designs that reduce acoustic signature; small, low cost high endurance UAV's capable of destroying most enemy UAV's; and short distance take off and landing of fixed wing aircraft.

(U) The Network Centric Enabling Technology project funds sensor, signal processing, detection, tracking and target identification technology development required for true network-centric tactical operations. Technologies developed in this project will enable localized, distributed and cross-platform collaborative processing so that networks of sensors can rapidly adapt to changing force mixes, communications connectivity and

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mission objectives. Operational benefits will be smaller forward deployment of image and signal analysts, consistent integration of target and environment information, and flexible operational tactics and procedures for finding evasive targets in difficult environments.

(U) **Program Change Summary:** *(In Millions)*	**FY 2005**	**FY 2006**	**FY 2007**
Previous President's Budget	327.825	361.562	418.818
Current Budget	316.673	346.076	383.680
Total Adjustment	-11.152	-15.486	-35.138
Congressional program reductions	-.0261	-26.886	
Congressional increases	0.000	11.400	
Reprogrammings	-2.500		
SBIR/STTR transfer	-8.391		

(U) Change Summary Explanation:

FY 2005	Decrease reflects SBIR/STTR transfer, a DOE transfer for P.L. 108-447 and a below threshold reprogramming.
FY 2006	Decrease reflects the $20M congressional reduction to the Walrus program, FFRDC reduction, undistributed reductions for Section 8125 and the 1% reduction for Section 3801: Government-wide rescission offset by congressional adds to R31 systems, CEROS, MESH- Enabled Architecture, Counter Sniper/RPG and Enhancement of Communications and Telemetry Support Equipment.
FY 2007	Decrease reflects reduced funding for the Friction Drag Reduction in Project TT-03, Naval Warfare Technology, and termination of the Walrus effort in Project TT-07, Advanced Aeronautics Technology.

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Naval Warfare Technology TT-03	41.295	52.344	38.497	31.443	30.190	30.190	30.190

(U) Mission Description:

(U) The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities such as drag reduction, hypersonic missiles, logistically friendly distributed lighting systems, ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations, acoustic anti-submarine warfare and predictive tools for small craft hydrodynamic design.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Friction Drag Reduction	3.142	13.009	5.125

(U) The Friction Drag Reduction program will develop and demonstrate physics-based, predictive engineering design tools that will yield additive-based friction drag reduction on Navy surface ships that exceed the cost of implementation. Such a capability would result in decreases in fuel usage, increases in burst speed, and enhancements in vehicle range and endurance. To date, the program has developed the capability to predict from first-principles how turbulent flows are modified by the presence of polymers and microbubbles. These first-principles models were validated with small-scale physical experiments and initial tests in a large scale facility at ship-relevant scales. This predictive capability will be extended and tested at large scales, using an optimized injector in a blind-test of the prediction and design tool in the large scale facility. The predictive capabilities will be validated using large-scale experiments conducted on a 13 meter long flat plate at the U.S. Navy's William B. Morgan Large Cavitation Channel. Finally, these large-scale predictive models will be used to design an optimal implementation of additive-based drag reduction technology for a realistic at-sea test (e.g., small surface ship).

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(U) Program Plans:

- Refined multi-scale modeling capability incorporating the physics learned in large-scale tests into engineering codes for use as reliably predictive design tools.
- Conducted a large scale micro-bubble experiment to provide high-quality data at large scales in order to validate the models.
- Conducted a large scale test of polymer injection to provide high-quality data at large scales in order to validate the models.
- Finalized design of refined injection system for additional large scale micro-bubble testing.
- Initiated second series of micro-bubble tests with refined injection system design.
- Completed preliminary design of refined injection system for additional large scale polymer testing.
- Verify predictive capabilities of microbubble and polymer models.

	FY 2005	FY 2006	FY 2007
Surface Warfare Automated Shiphandling (SWASH)	1.900	4.914	3.728

(U) The Surface Warfare Automated Shiphandling (SWASH) program will develop and demonstrate technologies to increase survivability and operational effectiveness of small and medium naval surface vessels in rough seas. Currently, vessels are at the mercy of ocean waves, and when waves become sufficiently large, damage and capsizing can occur. SWASH will enable safe operations in an expanded sea state envelope. SWASH combines detailed sensing and wave prediction of the local sea surface with improved understanding of vessel dynamics in a control system that provides optimum course and speed to the vessel's rudder and engines. SWASH offers the potential to reduce injuries to crew and passengers as well as damage to vessels caused by high waves. In addition, SWASH is an enabling technology for unmanned surface vessels (USVs), which will be a component of the modules for the Navy's new Littoral Combat Ships (LCS). SWASH will increase the survivability and operability of USVs in rough seas, and can provide inputs to the LCS steering system to make USV launch and recovery faster and safer. Medium manned vessels, such as LCS, DD(X), and current classes, will benefit from the more detailed knowledge of wave fields that will be developed in the SWASH program. Sophisticated steering strategies can reduce damage to the vessels caused by high waves, and improve human performance by reducing vessel motions.

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(U) Program Plans:
- Refine prediction capability for ocean wave fields.
- Improve models of small craft dynamics in high sea states.
- Develop control algorithms for wave avoidance.
- Test control schemes in "virtual ocean" environment and scale model tests, as well as at-sea testing.

	FY 2005	FY 2006	FY 2007
Hypersonics Flight Demonstration (HyFly)	19.615	11.882	9.476

(U) The Hypersonics Flight Demonstration program (HyFly) will develop and demonstrate advanced technologies for hypersonic flight. Flight-testing will be initiated early in the program and progress from relatively simple and low-risk tests through the demonstration of an increasingly more difficult set of objectives. The ultimate goals of the program are to demonstrate vehicle performance leading to a tactical surface launched missile range of 600 nautical miles. Specifically the program will demonstrate an F-15 launched missile configuration with a range of 400 nautical miles with a block speed of 4,400 feet per sec, maximum sustainable cruise speed in excess of Mach 6, and the ability to accurately terminate the missile on a GPS guided impact target. Technical challenges include the scramjet propulsion system, lightweight, high-temperature materials for both aerodynamic and propulsion structures, and guidance and control in the hypersonic flight regime. Recently demonstrated performance in ground testing of the dual combustion ramjet engine coupled with advances in high temperature, lightweight aerospace materials are enabling technologies for this program. The core program will focus on development and demonstration of capabilities requisite for an operational weapon. A separate effort will be performed in parallel to demonstrate advanced propulsion technologies and develop low-cost test techniques. DARPA and the Navy have established a joint program to pursue areas of the hypersonics program that would be relevant to maritime applications.

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(U) Program Plans:

- Performed preliminary and detailed design efforts and supporting materials-structural demonstrations.
- Conducted freejet aero-propulsion testing of the heavyweight vehicle configuration.
- Performed ground test verification (static firing) of supersonic low altitude target boosters.
- Performed advanced combustion systems proof of concept testing in gun-launched test range.
- Conducted ballistic and free-flight subscale testing of advanced engine technologies.
- Conduct captive carry, drop, boost performance and boost separation flight tests.
- Perform vehicle subsystems verification testing.
- Conduct flight weight vehicle environmental testing.
- Conduct flight weight vehicle freejet performance and durability testing.
- Conduct initial, low flight Mach (~Mach 4.0) flight-testing.
- Demonstrate Mach 6.0 cruise and extended range (400 nm).

	FY 2005	FY 2006	FY 2007
High Efficiency Distributed Lighting (HEDLight)	5.672	2.354	2.000

(U) The High Efficiency Distributed Lighting (HEDLight) program seeks to fundamentally change the design for lighting systems on U. S. military platforms to increase survivability, deployability, and maintainability. Current lighting systems use electrical distribution and the generation of light at the point-of-use. HEDLight remote source lighting uses centralized light generation and optically transports the light to the point-of-use. This allows the lighting system electrical circuitry and wiring to be concentrated, protected, and removed to the interior of the warship, thereby removing a source of vulnerability from the outer-envelope. Critical metrics that are necessary for the successful implementation of HEDLight are system efficiency, weight, and control of the illumination pattern. The technical areas key to the success of the HEDLight program include the development of compact, high-efficiency, full-spectrum light sources; high-efficiency coupling optics; high-efficiency, integrated optical-fiber luminaries; and integrated illuminator engines that effectively combine the light source, the optical coupler, and fiber-luminaire.

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(U) Program Plans:
- Develop high efficiency full-spectrum light sources.
- Develop high efficiency optical coupling mechanisms.
- Develop high efficiency fiber-luminaries for distributed light transport.
- Develop an integrated high efficiency distributed lighting illuminator.
- Demonstrate a limited scale HEDLight system installed on a U.S. Navy ship.

	FY 2005	FY 2006	FY 2007
Center of Excellence for Research in Ocean Sciences (CEROS)	7.000	6.000	0.000

(U) The Center of Excellence for Research in Ocean Sciences (CEROS) encourages leading edge research and development in ocean sciences, by involving highly specialized small businesses with recognized expertise in ocean related research, and providing access to the ocean sciences expertise of the University of Hawaii. Major research areas of interest have included shallow water surveillance technologies, ocean environmental preservation, new ocean platform and ship concepts, ocean measurement instrumentation, and unique properties of the deep ocean environment.

(U) Program Plans:
- Select projects for funding.
- Contract selected projects and monitor progress of ocean related technologies of high interest to the DoD.
- Transition appropriate products to military use.

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	FY 2005	FY 2006	FY 2007
Acoustic Arrays for Torpedo Defense	3.966	3.760	2.000

(U) The Navy's Sea Power 21 vision requires future naval forces to have assured access to littoral waters. Sea Strike forces must have the ability to conduct maritime operations in the presence of diesel submarine threats and surface craft capable of launching torpedoes. The Acoustic Arrays for Torpedo Defense program will demonstrate the feasibility of using an array of transducers to form a destructive pressure pulse capable of disabling an enemy's torpedo. Of critical importance is the ability to accurately predict non-linear pressure pulse propagation effects and corresponding timing delays used during pressure pulse generation and beamforming. Additionally, the beamformed pressure pulse must be of sufficient amplitude and duration to destroy a torpedo at tactically significant ranges.

(U) Program Plans:
- Conducted non-linear pressure pulse propagation modeling and assessed projected system performance.
- Designed, developed and tested a single transducer.
- Design, develop, and test prototype transducer array.
- Conduct prototype system testing.

	FY 2005	FY 2006	FY 2007
Unique Propulsion Techniques (formerly Ribbon Fin Propulsion)	0.000	2.120	3.273

(U) The Unique Propulsion Techniques program will develop a novel underwater propulsion technology for Unmanned Underwater Vehicles (UUV) and other underwater platforms that require high maneuverability at low velocities. Electric eels using ribbon fin propulsion may be generating traveling chains of ring vortices, which give more momentum transfer than simply pushing the same quantity of fluid with no structure. The objective of the program is to develop a ribbon fin propulsion system and demonstrate the increased low velocity power efficiency and maneuverability of an actual underwater platform. The fundamental technical challenges include 1) determining if the traveling wave is structured

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to maximize thrust, 2) determining the structure of the fluid flow imparted by the ribbon fin, 3) determining how to implement a flexible ribbon structure with sufficient power and controllability to be useful, and 4) determining how to attach such a structure to a rigid body and integrate it with other control surfaces to gain additional degrees of freedom.

(U) Program Plans:
- Accurately model the physics of ribbon fin propulsion and create predictive design tools.
- Design and demonstrate a ribbon fin propulsion system on an appropriately scaled surrogate platform.

	FY 2005	FY 2006	FY 2007
Riverine Crawler Underwater Vehicle	0.000	3.120	3.613

(U) The Riverine Crawler Underwater Vehicle program will study means of operating in challenging conditions of obstructions, turbidity and current such as in rivers and harbors by an unmanned submerged craft. Novel means of navigation, propulsion and sensing will be required to operate autonomously in such environments.

(U) The scope of this program will be to explore the potential concepts and the technologies to perform these missions. The effort will identify the promising vehicle types and examine the system and/or component element technologies required to support these vehicles.

(U) Program Plans:
- Perform concept of operations (CONOPS) studies; set the basis of the technology survey, vehicle concept applicability evaluation and the process for identifying vehicle system and component technology concepts.
- Identify technologies to address various challenges that a set of defined vehicle types and sensor payloads must face in the riverine environment and what possible forms the vehicle could take in order to address each of the mission challenges.

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	FY 2005	FY 2006	FY 2007
Fast Boat (formerly Small Craft Advanced Hydrodynamic Design)	0.000	5.185	3.582

(U) The Fast Boat program will design, build, and demonstrate one or more boats with threshold speeds of 70 knots and an objective speed of 100 knots in high sea states with a ride quality that is a significant improvement over existing boats. The designs will be tailored to special operations and will be sized for the missions of boats used by the special operations community. Boats produced in this program could also be used to support the Navy's Riverine mission.

(U) Today's boats are capable of high speed in calm water but not in moderate or high sea states. Poor ride quality in existing boats used for special operations results in a very high incidence of crew and passenger injuries in moderate or high sea states. The Fast Boat program will demonstrate designs capable of both high speed and good ride quality in sea states 3-5 and will investigate the operational benefit of high speed in special operations.

(U) Program Plans:

- Complete trade systems and preliminary design.
- Fabricate one or more full-scale demonstrators.
- Conduct performance demonstrations in low, moderate, and high sea states.
- Complete a limited user test in which the operational value of speed is explored and quantified.

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	FY 2005	FY 2006	FY 2007
Super-Fast Submerged Transport (Underwater Express)	0.000	0.000	3.500

(U) The Super-Fast Submerged Transport (Underwater Express) program will demonstrate the first application of manned vehicle supercavitation enabling high speed transport of personnel and/or supplies. The inherent advantages of traveling underwater are: ability to transit clandestinely, no radar or visible signature, and avoidance of rough sea conditions that may limit or deny mission execution. Supercavitation places the vehicle inside a cavity where vapor replaces the water, and viscosity is reduced by orders of magnitude, thus reducing the power requirement dramatically. This program will design an underwater vehicle that can operate close to the surface where cavitation can occur more easily (lower vapor pressure), and, by augmenting the cavitation with forced ventilation, a marked decrease in cavitation speed is possible. Innovative failsafe control will be required for stability and maneuverability at speed.

(U) Program Plans:

- Develop models and simulations to predict cavity and cavitator performance.
- Design a vehicle concept.
- Conduct subscale testing in a controlled facility.
- Design, fabricate and test a scaled prototype vehicle.
- Test in wire guided pond for failure modes and responses.
- Analyze against metrics for speed/power and stability.
- Incorporate model test results into design.

	FY 2005	FY 2006	FY 2007
Wideview	0.000	0.000	2.200

(U) This program will exploit a technology used successfully by the underwater acoustic community and convert it to give tactical aerial vehicles the ability to continuously detect, locate and track battlefield sounds (such as sniper firing) over a whole 360° field of view.

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(U) Program Plans:

- Measure airborne towed array noise.
- Adapt current capabilities from water to the higher speeds of air vehicles. Perform system analysis to assure compatibility of towed arrays with UAV performance.
- Develop acoustic models through computational techniques and limited airborne testing to account for background clutter. Assure fires detection range at least 10km from UAV at 5,000 feet, and the tracking of combat vehicle noise at a similar range.
- Develop a prototype system.

(U) Other Program Funding Summary Cost:

	FY 2005	FY 2006	FY 2007
Hypersonics Flight Demonstration			
PE 0602114N, PE 0603114N, PE 0603123N, Navy, Office of Naval Research	15.000	11.300	2.200

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Land Systems Technology TT-04	64.065	71.306	74.299	99.927	116.365	122.279	129.109

(U) Mission Description:

(U) This project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations. The emphasis is on developing affordable technologies that will enhance the military's effectiveness while decreasing the exposure of U.S. or allied forces to enemy fire. This project consists of the following programs: Novel Sensors for Force Protection; Dynamic Optical Tags (DOTS); Guided Projectiles; Networking Extreme Environments (NetEx); MAgneto Hydrodynamic Explosives Munition (MAHEM); Compact Military Engines; Crosshairs; Improved Explosives; Agile Interceptor; Counter Improvised Explosives Laboratory (CIEL); National Cyber Security Center; Stimulated Isomer Energy Release (SIER); Vertical Infiltration, Persistent Extraction Robot; Sweeper; and Maneuver and Control on the Urban Battlefield.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Novel Sensors for Force Protection	10.910	12.459	15.352

(U) The Novel Sensors for Force Protection program is exploring and developing a variety of novel methods that will contribute to enhanced protection of U.S. warfighters and address hostile situations encountered by U.S. warfighters in the Global War on Terrorism, Operation Enduring Freedom and Operation Iraqi Freedom. The motivation behind all of the programs is to reduce the exposure of U.S. warfighters when they are operating in disadvantageous territory, especially those complex settings (densely populated and structured areas, multi-storied buildings, etc.) typically found in urban settings. The Novel Sensors program consists of the Unique Signature Detection Project (formerly known as the Odortype Detection program), the Enemy Dismount Intrusion Detection Project, the Urban Vision Project, and congressionally added funds for Tactical Awareness for Friend or Foe.

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(U) The objective of the Unique Signature Detection program is to determine by means of a well-developed scientific methodology whether there are unique signatures in emanations that can be used to identify and distinguish specific high-level-of-interest individuals within groups of enemy troops or combatants, and if so, to develop enabling technology for detecting and identifying those specific signatures. The program consists of an interdisciplinary team of performers using state-of-the-art techniques to evaluate the statistical, biological and chemical nature of individual emanations. Once the nature of the chemosignal has been characterized, performers will determine the impact of non-genetic factors (e.g., diet, stress, health, age) on the signal in order to determine whether the signal can be robustly extracted from a complex and varied chemical background. If an exploitable robust signature is identified, the program will then pursue detector development.

(U) The Enemy Dismount Intrusion Detection program will develop a chemical sensor that is capable of providing an advanced warning of the presence of enemy troops or combatants by detecting the chemical emissions or pattern of emissions that are common to all humans, but are otherwise not ordinarily encountered in the environment. This program will leverage capabilities found in nature to recognize and locate the volatile chemicals that are the most reliable indicator of the presence of enemy troops or combatants leading to the development of a sensor and detection scheme that will be capable and robust against false alarms. This detection capability would replace land mines as a way to provide advanced threat warning of approaching enemy combatants to troops involved in perimeter defense and similar operations.

(U) The goal of the Urban Vision program is to enable the warfighter to ‘see’ movers within a building using a variety of fused multi-spectral techniques. The objective is to develop a necessary and sufficient number of sensor breadboards that can demonstrate the capability to the user community. The application is in-building take-down operations, where the user enters the building through the roof. The sensors will be placed on the roof to give information on the number and location of occupants in the floor immediately below. The sensors must be small and light weight. The system must operate with a minimal number of sensors (the goal is four). Technical challenges include understanding the fundamental physics limitations of various techniques, fusion and developing a combined sensor and networked communications transceivers with required size, weight and power for candidate platforms.

(U) Program Plans:

- Unique Signature Detection
  - Identify the chemical make-up of the Major Histocompatibility Complex (MHC)-determined unique signatures.
  - Examine the chemistry and impact of non-genetic background signals and develop receiver operator curves (ROC) for performance.

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  - Design detectors that are capable of identifying high-level-of-interest individuals within groups of enemy troops or combatants through unique, specific signatures with high reliability.

- Enemy Dismount Intrusion Detection
  - Determine the required performance of a chemical emission sensor as part of a system of sensors in a perimeter defense.
  - Determine the chemical emissions that are unique to humans and therefore to all enemy dismounted troops and combatants.
  - Determine the specificity of the human chemosignal in a variety of complex backgrounds.
  - Design detectors capable of reliably indicating the presence of enemy dismounted troops and combatants with a low false alarm rate.

- Urban Vision
  - Design, develop, and evaluate an initial (fixed placement) multi-static multi-frequency dielectric imaging array test system.
  - Establish baseline system performance parameters for spatial resolution and dielectric differentiation.
  - Develop algorithms for inverting the multi-static imaging data to reveal the interior structure and distribution of objects within the structure, and the coarse categorization of those objects with sizes typically associated with enemy troops or combatants and dielectric characteristics.
  - Design, develop, and demonstrate an array multi-static dielectric tomography imaging system.

	FY 2005	FY 2006	FY 2007
Dynamic Optical Tags (DOTS)	8.819	10.875	7.145

(U) Based on the technical successes and demonstrated operational relevance of DARPA's now completed Optical Tags program, the Dynamic Optical Tags and Sticky Flares programs seek to create new tagging, tracking, designating, and locating capabilities for U.S. forces. These programs will develop optical tagging, interrogation, and designation technologies that will enable small devices such as environmentally robust, retro reflector-based tags and highly-visible designators that can be read by both handheld and airborne sensors at significant ranges. These tags can be used for unique, non-radio frequency (RF) identification of items of interest, monitoring tactical areas for disturbance from personnel and

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vehicles, and designating targets in complex environments. The identification tags also will be capable of providing persistent two-way communications for both tactical and logistics operations.

(U) Program Plans:
- Identified promising retro reflecting and designating techniques.
- Developed most promising retro reflecting and designating techniques into tag design.
- Develop novel emplacement technologies.
- Develop handheld and airborne interrogation systems.
- Integrate and test components in a fully functional configuration.

	FY 2005	FY 2006	FY 2007
Guided Projectiles	16.078	18.572	12.893

(U) The Guided Projectiles program is developing and demonstrating highly maneuverable gun-launched projectiles, and associated fire control and launch systems for employment against critical enemy infrastructure and point targets, such as command, control and communication nodes and radars. This program will develop enabling technologies to give U.S. warfighters the ability to allow weapons platforms, such as mortars, to receive updated target information from other munitions or sense target changes on their own. Based upon this information, the platforms can adjust course in flight to prosecute highly-mobile, time-sensitive targets such as those encountered during Operation Enduring Freedom and reduce the potential for collateral damage. This program will adapt recent advances in communications, computers, sensing and propellants/explosives to demonstrate significant leaps in combat capability. The technologies being developed will demonstrate the increased combat effectiveness and the reliability of distributed, collaborative processing and mission execution.

(U) The program will develop a low-cost, non-imaging optical seeker/guidance unit exploiting technology development in the visible and infrared spectrum that will replace the current 60mm mortar fuse to improve firing precision. Additionally, research will be done with explosives to improve the effectiveness of 60mm explosive rounds. The goal is to develop a 60mm projectile with the effectiveness of a 105mm high explosive projectile.

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(U) The program also developed small aperture, geolocation capabilities for a new-class of anti-radiation weaponry and enabled a suite of weapon sensor and guidance systems that homed and guided on the RF energy emitted by enemy forces. The potential applications include ground-to-ground, air-to-ground, and ground-to-air weapons all using similar RF sensor guidance technology. The result of this effort could create a passive, all-weather, and inexpensive precision targeting capability for precision and area suppression weapons and counter enemy signals camouflage, concealment and detection efforts. The initial effort focused on providing an RF sensor, guidance and warhead package capable of being fired out of an 81mm mortar.

(U) A portion of this program will investigate supersonic interceptors that provide high rate, multiple engagement defenses of critical tactical or strategic assets, including naval surface ships, airborne intelligence, surveillances, and reconnaissance platforms, and fixed radar/command, control and communications sites. Supersonic flight control for aggressively maneuvering medium caliber projectiles will be developed and integrated into advanced projectile designs to achieve lateral accelerations far exceeding those achieved by “course-correcting” projectiles.

(U) Program Plans:

- Developed, modeled and validated supersonic flight control technologies.
- Conducted preliminary development and evaluation of key subsystem technologies.
- Performed initial flight demonstrations and target acquisition demonstrations.
- Fabricated and tested critical subsystems for projectile maneuvering, guidance and data transmission.
- Develop mortar seeker using an array of non-imaging optical lenses.
- Develop small and responsive mortar guidance/control/steering fin system.
- Integrate seeker with guidance/control/steering system into a unit that replaces the current fuse on the 60mm high explosive mortar.
- Develop designator systems that provide visible and infrared light emissions from a target compatible with the optical/guidance unit.
- Demonstrate tube launch of 60mm optically guided mortar round and optical designating system in conjunction with USMC.

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	FY 2005	FY 2006	FY 2007
Networking Extreme Environments (NetEx)	6.801	4.978	4.907

(U) The Networking in Extreme Environments (NetEx) program will create a wireless networking technology for the military user that will enable robust connectivity in harsh environments (for example, areas prone to multipath interference such as urban settings where buildings and other structures cause RF energy to "bounce" off, in and amongst the buildings/structures) and support development of new and emerging sensor and communication systems. This program will develop an improved physical layer for networked communications based on a family of new ultra wideband (UWB) devices. These devices will enable reliable and efficient operations in harsh environments by exploiting the unique properties of UWB systems that allow them to work in a dense multi-path environment and to function as both a sensor and communications device. The program will adapt new and emerging ad-hoc routing protocols and multiple access schemes to take advantage of the unique properties of UWB to communicate in harsh environments, to very accurately resolve range, and to act as a radar based sensor.

(U) Program Plans:
- Characterized the effect of UWB system operation on military radio frequency receivers.
- Determined the thresholds of interference of UWB, which are caused by legacy equipment and methods by which it can be reduced.
- Developed an improved UWB physical layer.
- Develop a Tactical Voice/Data Radio (TVDR) with ranging.
- Develop a low bit rate sensor network with highly accurate geolocation.

	FY 2005	FY 2006	FY 2007
Magneto Hydrodynamic Explosive Munition (MAHEM)	4.180	4.880	5.135

(U) The Magneto Hydrodynamic Explosive Munition (MAHEM) program will demonstrate compressed magnetic flux generator (CMFG)-driven magnetohydrodynamically formed metal jets and self forging penetrators with significantly improved performance over explosively formed jets and fragments. Explosively formed jets (EFJ) and self forging penetrators (SFP) are used for precision strike against targets such as armored

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vehicles and reinforced structures. Current technology uses chemical explosive energy to form the jets and fragments. This is highly inefficient and requires precise machining of the metal liners from which the fragments and jets are formed. Generating multiple jets or fragments from a single explosive is difficult, and the timing of the multiple jets or fragments cannot be controlled. MAHEM offers the potential for higher efficiency, greater control, the ability to generate and accurately time multiple jets and fragments from a single charge, and the potential for aimable, multiple warheads with a much higher EFJ velocity, hence increased lethality and kill precision, than conventional EFJ/SFP. MAHEM could be packaged into a missile, projectile or other platform and delivered close to target for final engagement and kill. This could provide the warfighter with a means to address stressing missions such as: lightweight active self-protection for Future Combat Systems (FCS) vehicles (potential defeat mechanism for a kinetic energy round); counter armor (passive, reactive, and active); mine countermeasures; and anti-ship cruise missile final layer of defense.

(U) Program Plans:

- Refined magnetohydrodynamic models of MAHEM behavior.
- Continue capacitor-driven liner experiments to validate models.
- Complete single CMFG and MAHEM concept designs.
- Develop and conduct experiment demonstration of CMFG and CMFG-driven MAHEM.
- Develop MAHEM variants tailored to mission-specific requirements.

	FY 2005	FY 2006	FY 2007
Compact Military Engines	2.117	2.210	0.570

(U) As military systems become more mobile and autonomous, and able to carry out missions with greater endurance, they will require a new generation of engines that are lighter, more compact and consume less fuel. Further, the military is requiring that the new generation of engines consume only logistic fuel (JP-8). The Compact Military Engines Program will apply innovative ideas for engine design to produce performance gains not obtainable by further refinement of conventional designs. The ideas will, for example, eliminate heavy accessory components, such as the valve drive trains, and eliminate sources of lost power, such as piston side forces causing friction and thermal conduction through cylinder walls. The Compact Military Engines Program will address various engine types and diverse missions. A goal of the program is to decrease the

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size of mobile electric power generators by a factor of ten. Improvements to electric generators for hybrid electric vehicles will increase vehicle range and endurance.

(U) Program Plans:
- Completed concept design.
- Demonstrate critical technologies.
- Build and test prototype engines to demonstrate continuous operation at substantial power levels.
- Build and test prototype engines to demonstrate full performance.

	FY 2005	FY 2006	FY 2007
Crosshairs	4.060	7.370	9.000

(U) This program will develop methods and equipment to enable blue-team forces to detect, locate, and engage shooters and defeat a variety of common threats including bullets, Rocket Propelled Grenades (RPGs), Anti-Tank Guided Missiles (ATGMs), direct fired mortars, and Man Portable Air Defense Systems (MANPADS), both stationary and on the move. Threat identification and localization will be determined in sufficient time to enable automatic and man-in-the-loop response options. During Phase I the program will design, develop, and test candidate sensor systems. During Phase II, selected sensor systems will be demonstrated on a vehicle for on-the-move performance assessment, and will be integrated with self defense and response systems. Automated responses such as imaging for forensic and judicial evidence, rapid dissemination of location of combatants to allow both effective concealment and counterfire, slew to cue weapons, protective measures against RPGs followed by counterfire, and elimination of threats are also candidates for the operational system.

(U) The Concept of Operations is to provide HUMMWV-mounted detection and response systems that operate while on the move and a lightweight portable freestanding low power unit for platoons or squadrons while stationary. Techniques for supporting detection and false-alarm rate mitigation will be considered, including acoustic detection, optical, and radar detection. It is envisioned that the system will provide a significantly improved capability to detect and engage shooters during hostile and peacekeeping operations in both urban and non-urban environments. Technology challenges of particular interest are: low false rate algorithms, high speed reactive sensor techniques for a 360 degree

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azimuth and 60 degree elevation detection zone; robust data collection for tracking firing source; fast response and affordable solutions. The program will culminate with a series of prototype demonstrations of the system(s) in typical combat environments.

(U) Program Plans:
- Identify and develop ultra-fast sensors and algorithms to detect and track multiple threats in near real time.
- Perform component testing and conduct detection and shooter localization demonstrations.
- Analyze data and integrate sensors and response system with appropriate vehicle mounted counter-measures.
- Assess utility for dismounts.

	FY 2005	FY 2006	FY 2007
Improved Explosives	0.000	4.395	5.400

(U) The Improved Explosives program seeks to develop more effective explosive munitions. Such improvements are envisioned to provide U.S. small infantry units with organic firepower equal to light and medium artillery units. The explosives will provide U.S. forces with dominant capabilities in urban area operations by allowing the projection of superior destructive power against high-value targets. In addition, improved explosives will aid in denying sanctuary to enemy assets, including those hidden in armored, hardened or buried locations. The goal of the program is to develop systems that deliver three to five times more power (pound-per-pound) than conventional systems. The program will also evaluate and develop techniques for improving the effectiveness and efficiency of explosive energy. In addition, this effort will consider application of such improved explosives to wall/building breaching and improved explosive device (IED)/ordnance neutralization.

(U) Program Plans:
- Conduct initial studies, modeling and simulation to determine the feasibility of candidate technologies.
- Conduct experimental field tests to validate models.
- Design and develop improved munitions.

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	FY 2005	FY 2006	FY 2007
Agile Interceptor	0.000	4.000	5.330

(U) The Agile Interceptor program will develop and demonstrate a projectile system to protect limited areas (e.g. 1-2 km square) against mortar / artillery / rocket rounds, and potentially vehicles or helicopters from rocket propelled grenades, man portable air defense systems (MANPADS), and anti-armor rockets (e.g., TOW). The program will demonstrate an Agile Interceptor that will have the ability to maneuver very rapidly and with sufficient accuracy to engage the selected threat types while still remaining affordable. Relative to other options, the Agile Interceptor will be lower cost and will have significantly reduced collateral damage. The program will be multi-phased with frequent user reviews to ensure that the resulting products are meaningful and affordable. The program plan has various area and platform defense options that the Government will select after the initial phase of the program. The program will culminate with a series of prototype demonstrations of the capabilities in a realistic test environment.

(U) Program Plans:
- Define system architecture and constraints in conjunction with user / technical group.
- Develop and demonstrate critical technologies and evaluate to determine system effectiveness and cost.
- Initiate second phase to improve selected technologies and integrate them into the overall interceptor system.
- Demonstrate live fire intercept of mortars and other selected threats.

	FY 2005	FY 2006	FY 2007
Counter Improvised Explosives Laboratories (CIEL)	1.000	1.567	1.567

(U) Improvised explosives (IEs) are considered one of the most popular methods used by terrorist groups. Over the past 20 years, IEs have become very common due to their easy preparation and the high availability of raw materials. Efficient methods for detecting and neutralizing/desensitizing sensitive explosives labs in an urban environment will minimize interference with troop operations and minimize collateral damages. The goal of the Counter Improvised Explosives Laboratories (CIEL) program is to develop the infrastructure and

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methodology for novel chemo-sensors that will identify labs that are building IEs to a very high degree of specificity and reliability; and develop the infrastructure for tools for safe handling of improvised explosives and their mixtures.

(U) Program Plans:
- Develop a chemo-sensor that would provide a clear and fast identification of the target explosive.
- Identify a physical method that will neutralize bulk explosive materials.
- Conduct feasibility demonstrations.
- Optimize and demonstrate the sensor.

	FY 2005	FY 2006	FY 2007
National Cyber Security Center	1.000	0.000	0.000

(U) Future weapon systems for the tactical warfighter has increasingly relied upon the ability to transmit, receive, store and manipulate information. The security of this information is paramount and the techniques to accomplish this needed to be on the cutting edge to properly protect emerging, advanced weapons systems. The National Cyber Security Center will ensure that these capabilities are explored.

(U) Program Plans:
- Determined the feasibility of a National Cyber Security Center for advanced tactical weapon systems.

	FY 2005	FY 2006	FY 2007
Stimulated Isomer Energy Release (SIER)	4.000	0.000	0.000

(U) Nuclear isomers, such as hafnium 178m2, store in the nucleus 10,000 times as much energy per gram as TNT. The goal of the Stimulated Isomer Energy Release program was to develop a technique to control the release of this energy. The program demonstrated that as much energy can be released as is used to initiate the reaction (a breakeven experiment).

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(U) Program Plans:
- Determined if the hafnium isomer can be triggered with photons in the x-ray range that will release more than 50 times the energy input of the trigger.
- Identified a hafnium isomer production process that is affordable and cost effective.
- Developed a physics approach to a chain reaction for the hafnium isomer.

	FY 2005	FY 2006	FY 2007
Vertical Infiltration, Persistent Extraction Robot	5.100	0.000	0.000

(U) This program developed technologies to enable a robotic platform with high-degree-of-freedom mobility. System challenges to the development of the platform included: power generation, management and storage; locomotion; terrain and situational awareness; navigation and control; health and status monitoring; and position and configuration management. The program evaluated design approaches and concepts of operation for implementation and utilization of such a robotic platform.

(U) Program Plans:
- Performed risk reduction and feasibility studies of basic platform.
- Developed the integrated robotic system concept and conducted operator requirements study.
- Completed component testing to characterize system performance.

	FY 2005	FY 2006	FY 2007
Sweeper	0.000	0.000	3.500

(U) The goal of the Sweeper program is to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to provide a prototype multi function building clearing robot for tactical urban operations use. Urban building clearing operations are among the most difficult and lethal missions that dismounted troops undertake. A mobile hardened robot utilizing solely non-lethal force will

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compel adversaries to vacate vertical urban structures. U.S. forces will be able to secure the perimeter of the structure while the Sweepers cause adversaries to vacate the structure and force them into a position of capture. The goal here is two fold: (1) demonstrate a hardened mobile human size (0.2 m^3) robot capable of robust operations inside multi story buildings (navigation and mobility and survivable from threat engagement) and (2) demonstrate various non-lethal capabilities separately and from the robot, to include target acquisition, target identification, and teleoperated and autonomous engagement. Non-lethal capabilities to be demonstrated could include RF, optical, acoustic, and malodorants. The Sweeper platforms would possess autonomous mapping capabilities in order to channel the adversary into directed routes of egress.

(U) Program Plans:

- Develop and demonstrate robust urban robots in terms of navigation and mobility and survivability.
- Develop and demonstrate robotic mapping and cooperative channelization via multi-robot employment.
- Develop and demonstrate non-lethal capabilities.
  - -- Sensor teleoperation and communications.
  - -- Sensor autonomous operations.
  - -- Sensor selection and target identification.
  - -- Modular modality demonstration of RF and optical non-lethal system.
  - -- Modular modality demonstration of acoustic non-lethal system.
  - -- Modular modality demonstration of malodorant non-lethal system.
- Demonstrate prototype system in a harsh (hostile fire) cluttered urban structure for warfighter experimentation and utility assessment.

	FY 2005	FY 2006	FY 2007
Maneuver and Control on the Urban Battlefield	0.000	0.000	3.500

(U) This program will develop new, high speed, lightweight, and portable tools including bar cutters, rotary cutters, 5-25 ton spreaders, jamb breakers, deployable personnel barriers, and rooftop access devices. The ultimate program goal is to reduce the weight of existing access tools by 80% as well as deliver new and unique capabilities such as direct and rapid rooftop access and rapidly deployed personnel barriers.

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(U) Program Plans:

- Develop lightweight mechanical power sources optimized for the unique duty cycle of equipment that is useful in an urban fight, i.e., 1-2 minute bursts interspersed with idle periods where silence may be at a premium. The goal is to reduce the weight of the energy storage and power conversion system by a factor of ten.
- Develop lightweight versions of access and population control tool end effectors including spreaders, cutters, jamb breakers, personnel barrier dispensers, and rooftop access systems by utilizing lightweight composites and ceramics. Active structural control may also be used to reduce structural mass.
- Combine the new power systems with the end effectors to create a set of unique tools optimized for use in urban combat.

(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
Advanced Tactical Technology TT-06	107.096	97.375	111.706	115.074	125.256	125.256	125.256

(U) Mission Description:

(U) This project focuses on three broad technology areas: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasures, laser radar, holographic laser sensors, communications, and high-power laser applications; (b) high performance computational algorithms for signal processing, target recognition and tracking, electromagnetic propagation, and processing of advanced materials and microelectronics; and (c) enabling technologies for advanced aerospace systems and emerging payload delivery concepts. Additionally, this project will develop new tactical systems for enhanced air vehicle survivability, precision optics, electronic warfare, advanced air breathing weapons and training superiority systems. Studies under this project examine innovative approaches to non-invasive weapons detection, the use of laser and fiber-optic technologies to increase the survivability and lethality of existing systems, and the development of miniaturized and technologically advanced sensors, algorithms, and devices for monitoring assets.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
High Power Fiber Lasers	11.970	10.606	6.700

(U) The High Power Fiber Lasers program will develop and demonstrate single mode, single polarization fiber lasers with output powers greater than one kilowatt from a single aperture. Tens of kilowatts output power and capability to scale to greater than hundreds of kilowatts output power and beyond will be demonstrated through coherent combining of the output power from multiple fiber lasers. High power fiber lasers will provide a quantum leap in defense capabilities by simplifying the logistic train and providing a deep magazine, limited only by electric power, in a compact footprint. For theater/area defense and self-protection of combat platforms, they will provide speed of light engagement and flexible response against cruise missiles, reconnaissance unmanned air vehicles (UAVs), and rockets.

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(U) Program Plans:
- Demonstrate greater than 100-watt single mode polarized output power from a single large mode-field area fiber.
- Demonstrate greater than 1 kilowatt single mode single polarization output power from a single large mode-field area fiber.
- Demonstrate 1 kw single mode output power from coherently combining the out-power from greater than ten fiber lasers.
- Demonstrate tens of kilowatt output power and capability to scale to greater than hundreds of kilowatts output power.

	FY 2005	FY 2006	FY 2007
High Powered FemtoSecond Laser Diodes	3.851	4.000	4.000

(U) The development of high power, reliable semiconductor laser diodes with tunable femtosecond pulse widths and highly scalable power levels, represents a technological advance of great potential utility to the Department of Defense. The successful demonstration of a compact, efficient, and powerful laser diode system could lead to incredible advances in micromachining, communications, ultra-short pulse spectroscopy, light detection and ranging (lidar), and directed energy applications.

(U) Program Plans:
- Model and evaluate concepts for ultra-short pulse, high irradiance laser diodes and select mode locked grating coupled surface emitting laser diodes (GCSEL) and semiconductor optical amplification using chirped pulse amplification and compression.
- Develop a series of GCSEL-based ultra-short pulse, ultra-high power lasers culminating in a 1 milliJoule/200 femtosecond per pulse laser system with a 10 kHz repetition rate that can fit into a shoebox. This represents a seven order of magnitude jump in the performance of semiconducting laser diodes.
- Demonstrate the ability of femtosecond laser to micromachine complex Defense parts.

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	FY 2005	FY 2006	FY 2007
Super High Efficiency Diode Sources (SHEDS)	9.888	4.288	4.000

(U) The goal of the SHEDS program is to develop laser diodes that are 80% efficient in converting electrical power to optical power. These will be used for supplying the optical power to ytterbium (Yb) and neodymium (Nd) solid state lasers operating near 1060 nanometers (nm). Such high efficiency laser pumps for these solid state lasers will lead to dramatic reductions in the size and weight of 100kW class diode pumped solid state lasers.

(U) Program Plans:

- Achieve 80% efficiency from single diode bars.
- Achieve a spectral range of 880nm to 980nm, the range for pumping directly into the upper laser level of Nd and Yb.
- Provide wavelength stabilization to prevent thermal drift of the diode bar wavelength outside of the range of high absorption of the laser transition.
- Achieve a power level of 480W/cm^2 per diode stack operating continuously.
- Achieve a peak power of 2000W/cm^2 for operating the stacks in a quasi-continuous wave (CW) mode with a duty cycle of no less than 25%.
- Achieve much more efficient diode stacks that will reduce the waste heat to one third of that generated by currently available diode bars.

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	FY 2005	FY 2006	FY 2007
High Energy Liquid Laser Area Defense System (HELLADS)	26.502	20.000	25.000

(U) The goal of the High Energy Liquid Laser Area Defense System (HELLADS) program is to develop a high-energy laser weapon system (~150 kW) with an order of magnitude reduction in weight compared to existing laser systems. With a weight goal of less than 5 kg/kW, HELLADS will enable high-energy lasers (HELs) to be integrated onto tactical aircraft and will significantly increase engagement ranges compared to ground-based systems.

(U) The HELLADS program has completed design of a revolutionary high energy laser that supports the goal of a lightweight and compact high energy laser weapon system. An objective system laser module with integrated power and thermal management will be fabricated and demonstrated at an output power of 15 kW. Based on the results of this demonstration, additional laser modules will be developed and integrated with a beam control subsystem to produce a 150 kW laser weapon system demonstrator. The performance of the demonstrator will be characterized in a laboratory environment.

(U) Program Plans:

- Develop and test a 15 kW objective system laser module with integrated power and thermal management subsystems.
- Complete preliminary design of a 150 kW laser weapon system.
- Complete detailed design and fabricate a 150 kW laser weapon system.
- Demonstrate performance of a 150 kW HEL system.

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	FY 2005	FY 2006	FY 2007
Laser Star	3.585	2.800	2.000

(U) The Laser Star program will investigate technologies and techniques for reducing the effect of atmospheric turbulence and other effects on the quality and clarity of images obtained by ground based telescopes. Current technology uses natural stars or an artificial star (called a "guide star") to provide a reference image from which the effects of the atmosphere can be computed and cancelled. Natural stars limit the pointing of the telescope. Artificial guide star technology currently makes use of either stratospheric Rayleigh backscatter or mesospheric sodium resonance scattering. These techniques have been utilized to successfully demonstrate strategies for wavefront compensation, but suffer from practical restrictions limiting operational utility. Rayleigh guide stars can be effectively generated to altitudes of 15 – 20 km, beyond which decreasing air densities reduce the backscatter to the point where unrealistic laser powers are required for useful return signal. The altitude is insufficient to provide full atmospheric sampling and suffers from sensor/target signal cancellation. Sodium resonance scattering is available to 90 km, which is an essentially complete atmosphere sample, but the return is monochromatic and cannot provide information about turbulence-induced absolute tilt. Laser Star technologies being developed to overcome these shortfalls include advanced multi-conjugate adaptive optics as well as nonlinear techniques.

(U) Program Plans:

- Complete concept design.
- Develop experiment design and procure long lead items.
- Conduct experiment.
- Analyze data and integrate with atmospheric compensation programs.

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	FY 2005	FY 2006	FY 2007
Coherent Communications, Imaging and Targeting	8.720	6.200	6.225

(U) The Coherent Communications, Imaging and Targeting (CCIT) program will provide powerful new capabilities for secure communication up-links (multi-giga bits per second), and aberration free 3-dimensional imaging (greater than 1000 kilometers) and targeting at very long ranges. Innovative design concepts for MEMs based Spatial Light Modulators (SLMs), which provide a quantum leap in digital wavefront control, and system integration of photonics and high-speed electronics will also be explored. The CCIT program will develop a scalable prototype system and perform basic demonstrations of communications and imaging from ground to space in a highly cluttered environment. The CCIT system will address the critical need for high-data-rate communications and imaging from land, sea and airborne platforms to space.

(U) The counter swarm offense and defense project will explore innovative concepts for defending high value ships and ports against multiple missiles, fast boats and airborne threats, and offense against multiple ground targets. New capabilities achieved by advances in SLMs and advances in modulation of high power fiber lasers allow for seamless transfer or hand-off of digital radar target acquisition data and continuous wave (cw) range angle imaging. By imprinting target locations on SLMs, multiple targets can be simultaneously designated in parallel with orthogonal codes consisting of spatial (amplitude) and temporal (phase) modulations. This allows for a single laser designator system to direct precision or semi-active laser guided munitions to a large number of incoming closely spaced threats. In addition, the program will seek to decrease degradation of accuracy or cross talk between guidance signals by assigning unique orthogonal codes to the interceptors to prevent spoofing.

(U) The high data-rate optical communications project will exploit the characteristics of CCIT SLMs to dynamically generate orbital angular momentum (OAM) of photons. Using SLMS to change the OAM of photons in real-time as opposed to simply modulating the amplitude of light waves allows for significant improvement in data carrying capacity. Concepts will be developed for secure laser communications by parametrically down converting OAM states that provide higher order entangled states compared to polarization entangled states. The program will also develop system level architectures for secure free space optical communication networks.

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(U) Program Plans:

- Develop 256 x 256 element spatial light modulators and integrated electronics, with pixel flatness of one fiftieth of a wavelength, 98 percent fill factor, eight bits of phase resolution and ten micro-second response time.
- Demonstrate low elevation ground-to-space imaging of objects.
- Concept development of target acquisition and hand-off to spatial light modulators (SLM) arrays.
- Design laser transmitter and receivers for digital target acquisition data and cw range angle imaging.
- Develop concepts for unambiguous resolution and detection of orbital angular momentum (OAM) states.
- Develop concepts for secure free space communications.

	FY 2005	FY 2006	FY 2007
High Performance Algorithm Development	10.323	11.471	13.000

(U) The programs in this area identify, develop and demonstrate new mathematical paradigms enabling maximum performance at minimum cost in a variety of DoD systems applications. They will look for opportunities to aggressively leverage the power of mathematical representations in order to effectively exploit the power of large-scale computational resources as they apply to specific problems of interest. They also cultivate theoretical breakthroughs in areas of basic mathematics having relevance to emerging Defense sciences and technologies. The products are typically advanced algorithms and design methodologies. DARPA is pursuing the development of well-conditioned fast algorithms and strategies for the exploitation of high-dimensional data (i.e., data with a high number of degrees of freedom) in order to deal with a variety of complex military problems including digital representation and analysis of terrain and other geospatial data, efficient high fidelity scattering computations of radar scattering for predictive design and exploitation of radar cross sections, and efficient automatic mapping and optimization of signal processing kernels onto advanced Departmental computational hardware architectures.

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(U) Program Plans:

- Demonstrate efficient, accurate predictive algorithms for electromagnetic scattering from objects composed of inhomogeneous and anisotropic materials and including cracks, cavities gaps and thin edges; apply these codes to the accurate computation of radar cross section (RCS).
- Demonstrate efficient scattering codes capable of accurate computation of RCS for cruise-missile-sized vehicles with realistic material boundary conditions and full complexity components including high fidelity computational electromagnetic modeling capability for multisensor apertures and arrays.
- Develop innovative designs for analog systems with digital feedback control to extract high-level digital information from analog sources, such as digitized speech phonemes from acoustical signals or matched filter values from radar signals.
- Produce high-level algorithm-specification tools that will allow application domain experts (e.g., engineers in signal processing or fluid dynamics) to specify algorithmic Digital Signal Processing (DSP) library modules equal to expertly hand-tuned modules in one tenth the speed and power.
- Design and implement unified digital representations for map, terrain, and other geospatial data that will support highly efficient storage, query, and registration of geographical information from disparate sources.
- Demonstrate localized representations for high-altitude gravity data that provide the precision of current representations with ten percent of current storage requirements.
- Develop and test algorithms to exploit the presence of multiple scattering and clutter (e.g., foliage canopy) to enable imaging in the presence of multiple scattering and dispersion to enable image formation for acoustic, synthetic aperture radar, and active electro-optic sensors. Exploit multiple scattering and clutter to enable increased communication bandwidth at fixed power in acoustic and wireless applications.
- Create new system-level algorithms that are able to design and guarantee performance of complex systems while managing the uncertainty that is inherent in large, multiscale, highly interconnected systems where dynamics are important.
- Develop the required theoretical advances to establish rigorous foundations and methods in order to exploit recent discoveries of the presence of very low-dimensional intrinsic structure in large data sets of extrinsically high dimension.
- Develop techniques for self assembly of dynamic, non brittle, heterogeneous networks of surveillance and communications assets based upon mathematical inverse methods.

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	FY 2005	FY 2006	FY 2007
Integrated Sensing and Processing	8.865	5.000	5.000

(U) The Integrated Sensing and Processing program will open a new paradigm for application of mathematics to the design and operation of sensor/exploitation systems and networks of such systems by developing and applying novel optimization methodologies for integrating sensing, processing, and information exploitation functionality in sensor systems. This program will create tools enabling the design and global optimization of advanced sensor system architectures comprising fully interdependent networks of functional elements, each of which can fill the roles and functions of several distinct subsystems in current generation sensor systems. Payoffs will include improved performance with reduced complexity of hardware and software in a wide variety of systems, including agile adaptive arrays for missile seekers, unmanned air vehicles, and space-borne sensors; novel waveforms, adaptive waveform design and processing for object identification in dispersive and turbulent media; and novel approaches to multiplexed hyperspectral chemical/biochemical sensing systems.

(U) Program Plans:

- Develop and demonstrate new mathematical approaches to adaptive optimal control of tunable, mode-switchable, and configurable sensor systems/networks in which detection, estimation, classification, and tracking requirements determine sensing system operating parameters.
- Investigate extraction of high-level information directly from analog signals as part of the analog-to-digital conversion process, allowing joint optimization of traditionally separate sensing and processing functions.
- Develop real-time waveform design and scheduling strategies for ambiguity reduction and clutter mitigation in pulse diversity radar systems.
- Demonstrate feasibility of designs for quadrature thinning of two-dimensional conformal arrays that exhibit the same or better beam patterns than conventional arrays using fewer transmit/receive modules.
- Create new methods for processing sensor data and the design of sensors in which only non-redundant data is sampled to reduce sensor complexity, computational time and power consumption thereby dramatically improving sensor response.
- Develop information-theoretic metrics relating detection, estimation, classification, and tracking requirements to waveform structure in active sensing systems and use these metrics to devise new classes of mathematically optimal waveforms.

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	FY 2005	FY 2006	FY 2007
Training Superiority	12.563	15.831	24.271

(U) The Training Superiority program will change the paradigm for the way the military trains by creating new approaches to increase technical and physical competence as a result of revolutionary new training techniques developed in this program. Passive teaching approaches, including web-based training, will not succeed in instilling the skills and knowledge needed in the new land-battlefield, with higher demands on fewer soldiers, including the need to control and interact with highly technical unmanned systems. These new training approaches will include elements of human-tutor interactions and the emotional involvement of computer games coupled with the fidelity and feedback of Combat Training Center learning. In addition, these new training approaches will be linked into existing Service and Joint training systems to form a self-sustaining architecture, allowing continuous on-demand training anywhere at anytime.

(U) Program Plans:

- Develop, demonstrate and validate a continuously available, on-demand combat training system for all forces in the skills needed for successful performance across a comprehensive range of military operations, engagements and come-as-you-are wars.
- Develop, validate, demonstrate and deliver to military last-meter training systems that are focused on specific areas of performance requirements (e.g., “seabag sized” air mission trainer, tactical language instruction, convoy protection).
- Create an overarching training architecture populated with scalable multiple last-meter training systems that will allow any unit or individual, active, reserve, or civilian, to enter the virtual training world at any time, from any place, using existing hardware, and receive training tailored to specific individual training needs. Develop approaches to automatically insert lessons learned and incorporate realistic simulation of populations into that architecture.
- Exploit automated semantic analysis and multiplayer games to dramatically improve the training of teams and provide real-time feedback on team performance.
- Explore approaches for creating high-level cognitive competence through “training” of related non-cognitive functions.
- Exploit the use of multiplayer games to rapidly (weeks, not years) teach practical language and gestures to enhance interactions between soldiers and civilian populations. Investigate their use for improving the prediction of consequences of military activity.

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– Develop and demonstrate the use of computer simulations that can be updated with real world data in hours to allow truly realistic instant rehearsal of military operations to dramatically improve the planning and execution of those operations.

	FY 2005	FY 2006	FY 2007
Language and Speech Exploitation of Resources Advanced Concept Technology Demo	0.132	0.132	0.000

(U) DARPA's Compact Aids for Speech Translation (CAST) program developed speech translation technologies using handheld devices for military field operations. The Language and Speech Exploitation of Resources Advanced Concept Technology Demonstration (ACTD) program seeks to transition the CAST technology into the ACTD to support military utility assessments (MUAs). The application of information extraction techniques to speech translation has significantly advanced technology. This new technology will allow flexible and accurate translation of varying utterances without requiring recognition and translation of every word in the utterance.

(U) Program Plans:
- Installed a translator on small, readily available platforms (e.g., laptops, handhelds).
- Tested and evaluated language technology in the service labs.
- Transitioned the translator technology to the ACTD for MUAs.
- Continued to test and evaluate technology in operational context.

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	FY 2005	FY 2006	FY 2007
Air Laser	3.124	3.344	3.270

(U) The Air Laser program will investigate the potential for a high energy laser (HEL) concept based on direct diode pumping of liquid oxygen. If successful, the Air Laser could provide a safe, efficient kilowatt-to-megawatt-class HEL which combines the advantages of chemical and solid state lasers and minimizes the disadvantages: it operates in the eye-safe wavelength regime; it uses liquid oxygen as the gain medium and as the diode array coolant, resulting in the reduction or elimination of a separate thermal control system; it uses efficient, high power diode pump sources resulting in a compact device much smaller than either chemical or solid state lasers; and its pulse length is variable from continuous to sub-picosecond, allowing flexibility in weapons effects.

(U) Program Plans:

- Perform system/utility analyses.
- Develop and demonstrate a 1 kW output power laser design.
- Develop and demonstrate 20 kW laser design.
- Develop 100 kW-to-megawatt laser design.
- Develop kilowatt-class red diode stacks.
- Develop high-power mirror coatings for this wavelength.

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	FY 2005	FY 2006	FY 2007
Architecture for Diode High Energy Laser Systems	0.000	8.237	8.000

(U) This program will develop all-solid-state laser diode drivers with integrated fault mode protection that will decrease the size and weight of these laser systems by a factor of 4 (by allowing the laser diode array to operate at elevated temperature), increase the diode array lifetime tenfold, and decease lifecycle costs fivefold. These improvements will be attained for diode laser arrays operating in the IR, visible and ultra-violet regions of the spectrum. By allowing operation at higher temperatures, these new drivers will allow broader tuning of the laser light which is crucial to the detection of both chemical and biological agents with high signal-to-noise and low probability-of-false-alarm. These new diode laser drivers will utilize feedback control systems which detect electrical and optical filamentation within the laser diode and laser diode bars, and then interrupt power to the laser diode system before thermal instabilities can lead to accelerated diode aging and premature diode failure.

(U) Program Plans:

- Demonstrate a three-fold improvement in diode array lifetime with a preliminary data set that projects to tenfold improvements in diode lifetime.
- Integrate fault mode protection for stable operation of the laser diode array at elevated temperatures which leads to a fourfold reduction in the size and weight of the thermal cooling and heat exchanger systems which currently dominate laser size and weight.
- Combine new technologies being developed in industry and universities/government laboratories to provide the ultra-compact, tunable, solid-state lasers required for remote detection and destruction of both chemical and biological agents.

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	FY 2005	FY 2006	FY 2007
Photonic High Power Microwave System	0.000	1.000	2.000

(U) The goal of the Photonic High Power Microwave System program is to develop and demonstrate a highly compact high power microwave system capable of multiple waveforms and scaleable in power from the Gigawatt to Terawatt range. The enabling technology is the implementation of optically driven switches integrated directly into the radiating array structure. This technology will enable tactical air, land, and sea platforms to address directed energy missions ranging from electronic attack to anti-ship missile defeat.

(U) Program Plans:
- Conduct preliminary engineering studies.
- Perform initial concept development.

	FY 2005	FY 2006	FY 2007
Rapid Checkpoint Screening	5.010	4.466	3.740

(U) The Rapid Checkpoint Screening program will develop and demonstrate techniques and sensors to detect life-threatening deceptions in military controlled portals such as military checkpoints that are compatible with existing portal screen approaches.

(U) Program Plans:
- Identify physiological signals that correlate with deception including laser vibrometry, lidars, multi-spectral eye tracking, and short range electrical potential.
- Validate the measurement process.
- Establish new concepts for understanding deception processes on a scientific basis.

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	FY 2005	FY 2006	FY 2007
Efficient Mid-Wave Infrared Lasers (EMIL)	0.000	0.000	2.000

(U) The Efficient Mid-Wave Infrared Lasers (EMIL) program will develop efficient solid-state coherent sources to cover the atmospheric transmission bands in the mid-wave infrared (MWIR; 3-5 μm). Infrared countermeasure (IRCM) systems in particular depend on intense sources at these bands. The current generation IRCM systems utilize diode-pumped Tm lasers used to pump optical parametric oscillators (OPO), most commonly based on zinc germanium phosphide (ZGP).

(U) The lasers developed in this program will operate across the three relevant bands within the MWIR at 10W power with wallplug efficiencies of at least ten percent. By virtue of the enormous volumetric reduction (100-1000X), power reduction (10X), and superior pulse format (cw-operation), such sources will enable new architectures and approaches permitting IRCM systems to be deployed on platforms (e.g., rotocraft) which are highly vulnerable to Man Portable Air Defense Systems (MANPADS) and other threats but for which current IRCM systems are prohibitive or are inadequate (e.g., unable to defeat staring sensors). At least two diode-based laser approaches will be explored in this program, both involving antimonide-based compound semiconductor (ABCS) materials. These include intersubband-based quantum cascade lasers (QCLs) and type-II antimonide lasers, including so-called "W-configuration" approaches, the name taken from the shape of the conduction band profile.

(U) Program Plans:
- Design and deposition of complex multi-layered structures incorporating antimonides.
- Reduce internal losses across the large number of layers.
- Achieve the 10-W total output power by combining power of multiple devices.
- Overcome the parasitic mechanisms such as Auger recombination to reduce lasing threshold and achieve high temperature operation.

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	FY 2005	FY 2006	FY 2007
Sonic Projector	0.000	0.000	2.500

(U) The goal of the Sonic Projector program is to provide special forces with a method of surreptitious audio communication at distances over 1 km. Sonic Projector technology is based on the non-linear interaction of sound in air translating an ultrasonic signal into audible sound. The Sonic Projector will be designed to be a man-deployable system, using high power acoustic transducer technology and signal processing algorithms which result in no, or unintelligible, sound everywhere but at the intended target. The Sonic Projector system could be used for concealed communications in an urban environment with friendly or neutral subjects for hostage rescue.

(U) Program Plans:
- Complete initial feasibility studies.
- Create concept of operations and conduct military utility analyses.
- Develop and demonstrate initial prototype.

	FY 2005	FY 2006	FY 2007
Mission Specific Processing (MSP)	2.563	0.000	0.000

(U) The Mission Specific Processing (MSP) program extends technologies to support the design of highly optimized embedded processors that are required in the most severely constrained DoD applications. The technology developed by this program will facilitate high performance processing in future space based and miniature aero systems (unmanned air vehicles and missiles) that require extremely high processing throughput while consuming the minimum possible volume, weight and power. The focus is on providing a ten-fold gain in power-performance over current standard cell Application Specific Integrated Circuits (ASIC) designs by incorporating full-custom design optimizations into standard libraries. The MSP design flow methodology will be made available to organizations such as the Defense Microelectronics Activity (DMEA) and the Air Force Research Lab (AFRL). The MSP advanced processor will be used in DoD system demonstrations and an additional MSP chip test bed and radar simulator will be transitioned to the AFRL to enable potential Air Force system insertion.

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(U) Program Plans:

- Developed detailed system architecture of wideband adaptive radar/electronic intelligence-/seeker receiver enabled by MSP method.
- Developed a wideband adaptive radar receiver based on MSP custom cell libraries and modules.
- Conducted simulation and benchmarking of initial custom design techniques in the context of mission specific signal processing requirements.
- Demonstrated a ten-fold performance improvement in custom radar signal processing chips.
- Completed library of key digital signal processing function kernels and supporting tool augmentations.
- Completed development and demonstration of space-time adaptive processor for seeker-receiver.
- Conducted first pass evaluation of semi-custom, full scale chip in a space-time adaptive receiver testbed.
- Demonstrated full scale ASIC development using MSP architectures and techniques focusing on MSP design methodologies that reduce design time requirements as compared with full custom.
- Completed a demonstration that addresses system level issues and quantifies the increased performance relative to standard cell ASIC designs.
- Fabricated the MSP designed ASIC under DoD's Trusted Foundry program.

(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
Aeronautics Technology TT-07	47.876	58.290	78.027	84.462	100.452	105.752	80.752

(U) Mission Description:

(U) Aeronautics Technology efforts will address high payoff opportunities that dramatically reduce costs associated with advanced aeronautical systems and/or provide revolutionary new system capabilities for satisfying current and projected military mission requirements. This includes advanced technology studies of revolutionary propulsion and vehicle concepts; sophisticated fabrication methods and examination of novel materials for aeronautic system applications.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Micro Adaptive Flow Control (MAFC)	9.336	4.010	4.200

(U) Micro Adaptive Flow Control (MAFC) technologies enable control of large-scale aerodynamic flows using small-scale actuators. MAFC technologies combine adaptive control strategies with advanced actuator concepts like micro-scale synthetic jets, microelectromechanical systems (MEMS)-based microactuators, pulsed-blowing, combustion actuators and smart structures to cause the delay, or prevention of fluid flow separation. MAFC technologies have been and will continue to be explored for applications such as download and drag reduction for air vehicles, facilitation of long-range flight with reduced fuel consumption and logistical implications using vortex mitigation, adaptive lift-on-demand for agile missiles and uninhabited tactical aircraft, supersonic boundary layer control, lightweight gas turbine engines, and low-drag, non-intrusive methods to aerodynamically steer projectiles for extended range and precision.

(U) Program Plans:

- Executed Phase II, high speed, closed loop technology demonstrations.
- Executed MAFC download reduction testing on the XV-15.
- Completed SCORPION closed loop system design and fabrication.

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- Completed SCORPION Phase III technology roadmap.
- Complete sled design and fabrication for High Frequency Excitation for Supersonic Weapons Release (HIFEX) phase III test.
- Complete HIFEX system design and fabrication for HIFEX phase III test.
- Complete SCORPION system design and fabrication for SCORPION phase III test.
- Designed and integrated SCORPION full-scale control system.
- Complete 4 Mach 2.0 HIFEX system sled tests.
- Configure and execute Phase III full-scale technology demonstrations.

	FY 2005	FY 2006	FY 2007
Miniature Propulsion Concepts (formerly Small Scale Propulsion Systems)	7.995	5.340	5.334

(U) Small UAV payload and endurance capabilities can be expanded by increasing the power density and efficiency of their power plants. This program will develop concepts for small scale class propulsion systems. Small gas turbine engines are typically very inefficient, below 7% for engines below 10 horsepower. This program will develop gas turbine engines under 10 horsepower with a power density greater than 2HP/pound and a thermal efficiency greater than 25%. In addition, novel concepts for developing micro UAV's that emulate and/or borrow propulsion approaches from birds will be developed. These will provide a unique Intelligence, Surveillance, and Reconnaissance (ISR) capability for the dismounted soldier.

(U) Program Plans:

- Demonstrate small, long endurance engine using novel designs for un-cooled ceramic components with power density greater than 2 HP/lb, efficiency greater than 25% and a durability of greater than 500 hours.
- Demonstrate a multifunctional wing structure plus battery for micro air vehicles (MAV) that yields three times more duration than a traditional wing structure and conventional battery.
- Investigate compatibility of optical flow and uncooled IR approaches with multifunctional structures to enhance surveillance capability.
- Transition micro air vehicles to military applications.

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	FY 2005	FY 2006	FY 2007
Peregrine / UAV Killer	1.410	3.050	5.146

(U) The Peregrine Unmanned Air Vehicle (UAV) Killer program will develop a small, low-cost, high-endurance UAV, with a high dash speed, capable of destroying most enemy UAVs. Small UAVs with GPS guidance systems have reached such a low cost level that expendable UAV programs are now emerging and GPS capable avionics are available for the hobby market. Current options to counter such a threat, especially at high altitude, involve expensive ground launched anti-air systems or the exposure of manned interceptor aircraft. The Peregrine program will develop and demonstrate a UAV interceptor aircraft that will utilize a dual propulsive power system to provide very high endurance for the loiter and surveillance period, and a very high dash speed for intercept and kill. The program will also identify operating scenarios and system requirements for the protection zone approach for both domestic situations and regions of conflict, and will develop a suitable system design and concept of operations.

(U) Program Plans:
- Define system requirements.
- Develop concept design.
- Demonstrate aircraft performance and kill capability.

	FY 2005	FY 2006	FY 2007
Walrus	8.140	0.000	0.000

(U) The Walrus program was established to develop, evaluate, and demonstrate a range of technologies to enable the development of a very large airlift concept capable of controlling lift in all stages of air or ground operations including off-loading of payload without taking onboard ballast other than air. Unlike earlier generation airships, it would have been a heavier-than-air vehicle, generating lift through a combination of technologies and approaches including aerodynamics, thrust vectoring and gas buoyancy generation. The program planned to develop an operational vehicle (OV) concept and to conduct risk reduction demonstrations by executing a technology development and assessment plan

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including a Walrus Advanced Technology Demonstration (ATD) aircraft. The ATD vehicle and other technology demonstrations (bench tests and flight tests on other vehicles) would have demonstrated scalable aircraft technology to enable the achievement of the Walrus program goals. The program's first phase funded system studies and development of a notional concept of the objective vehicle and identification of the critical demonstration technologies to reduce risk for the concept. The program will complete at the conclusion of Phase I.

(U) Program Plans:

- Define and develop a notional objective air vehicle concept having a payload capability circa 500 tons.
- Identify critical breakthrough technologies.
- Complete final report.

	FY 2005	FY 2006	FY 2007
High Speed / Hypersonic Reusable Demonstration	15.000	30.000	20.700

(U) This program is a joint DARPA/Air Force initiative that is designing, developing and demonstrating a combined cycle engine and reusable hypersonic cruiser in conjunction with the Falcon program (PE 0603287E, Project SPC-01). Ultimately, the studies and developments under this project may result in the first controllable, recoverable, and reusable hypersonic system demonstration. Initial designs will allow for either a manned or unmanned version, and provide viable options for long-range strike and affordable access to space. The program is divided into two efforts—the High Speed Turbine Engine Demonstration (HiSTED) and the Scramjet Engine Demonstration (SED).

(U) The HiSTED objectives are to design, fabricate, and ground test a high Mach expendable turbine engine capable of Mach 3-4+ operation. The objective of the ground demonstration is to verify, via simulated altitude testing, that engine performance and operability characteristics at key transonic and maximum Mach/altitude cruise flight conditions meet anticipated system application needs. Successful completion of the Phase I ground demonstration will enable Phase II development of a reusable turbine-based combined cycle engine capable of accelerating a hypersonic cruise vehicle to Mach 4+.

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(U) The SED effort seeks to design, fabricate, and fly a hypersonic vehicle powered by the HyTech scramjet engine over a broad range of Mach numbers. The SED flight vehicle will be boosted to Mach 4.5 where the scramjet engine will be started and the vehicle will accelerate to Mach 6.5 to Mach 7+. This will demonstrate a scramjet engine that produces thrust greater than vehicle drag, accelerating a free flight vehicle over a range of Mach numbers. This will be the first-ever demonstration of a flight-weight, fuel-cooled scramjet-powered vehicle. It will also establish the viability of the scramjet engine for integration with high speed turbines such as that developed under HiSTED and/or rocket engines to create combined cycle engines for hypersonic cruise vehicles and affordable on-demand access to space systems.

(U) Program Plans:

- HiSTED
  - Complete high temperature turbine components design and fabrication.
  - Assess supercritical fuels.
  - Assess high temperature lubrications and bearings.
  - Perform component integration.
  - Conduct integrated engine ground testing.

- SED
  - Develop flight vehicle design.
  - Conduct freejet engine testing.
  - Fabricate flight demo vehicle.
  - Conduct flight testing.

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	FY 2005	FY 2006	FY 2007
Helicopter Quieting	5.995	6.020	8.472

(U) Studies and analysis of military helicopter operations have shown that the survivability and lethality of U.S. helicopters can be increased by reducing their acoustic signature, which will make them more difficult to detect, track, and engage. The Helicopter Quieting Program is developing revolutionary new rotor blade design tools that will enable the creation of novel rotor blades that can dramatically reduce the acoustic signature of a helicopter without sacrificing flight performance. Current rotor blade development is conducted on a trial and error basis, relying on an iterative cycle of analysis and model wind tunnel tests (time consuming and costly) or going straight from analysis to full-scale wind tunnel/flight test (high risk and costly). Because of the significant issues of time, cost, and risk, helicopter rotor designers cannot explore the revolutionary potential of emerging new rotor noise-reducing technologies in the design process. This program will leverage recent advances in computational fluid dynamics to develop physics-based predictive design tools that will allow designers to develop revolutionary rotor blade designs with vastly improved acoustic characteristics. The predictive tools will be tested using existing data sets and data collected from fully instrumented full-scale and model-scale experiments. The tools will then be used to design new blades that yield a significant reduction in low-frequency in-plane signatures without impacting performance compared to a baseline design.

(U) Program Plans:

- Develop predictive blade design tools.
- Conduct a study to guide the development goals for new blade designs based on operational models.
- Validate models using experimental data.
- Use the tools to support the design of new blades that yield a significant reduction in low-frequency, in-plane signature.

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	FY 2005	FY 2006	FY 2007
Nano-Flapping Air Vehicles	0.000	2.300	6.956

(U) The goal of this program is to develop flapping air vehicle technology that results in a bio-inspired flapping air vehicle with less than two inch wingspan and gross takeoff weight of approximately ten grams or less. Operations in the urban terrain require sensors that can navigate in difficult terrain and be inserted without being detected. Small air vehicles capable of navigating interior domains without GPS would enable autonomous prosecution of a number of high risk missions that are currently performed by warfighters. Key enabling technologies include, flapping wing aerodynamics, kinematics and flight dynamics, lightweight aeroelastically tailored wing structures, miniature navigation systems, micro-propulsion systems and small payloads. This effort will also examine novel materials that can be used to develop integrated wing structures, which change composition to achieve multiple expressions. The program would result in the use of vehicles, which could be camouflaged, or blend into the surrounding landscape, enabling in-theater disposal and prevention of mission detection/compromise.

(U) Program Plans:
- Conduct detailed investigations on unsteady aerodynamic physics to understand fundamental aerodynamic issues.
- Conduct studies integrating aeroelastic phenomena to improve flapping performance.
- Conduct survey/studies of novel building materials.
- Design wing geometry and flapping mechanism for future integration into vehicle design.
- Conduct detailed flapping tests to refine aerodynamic wing-mechanism design.
- Integrate wing design with air vehicle.

	FY 2005	FY 2006	FY 2007
Flare Aero Structures	0.000	2.000	4.500

(U) The Flare Aero Structures program will explore and develop a new approach to take off and landing of fixed wing aircraft. The landing field requirement for fixed wing aircraft limit their use in both confined (e.g. urban) and remote unprepared areas. This program will explore

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unsteady aerodynamics during rapid pitch up or flare landing maneuvers. It is known that very high lift coefficients can be obtained for a short period of time during such a maneuver. The technical challenge is to develop the aero structures, control effectors and control logic that will allow for a practical application of this phenomenon to fixed wing aircraft to allow landing in a very short distance. This could lead to small/medium UAVs that can land on unprepared areas without the need for an arresting system. Additionally, an application of this technology for paratroops will be evaluated.

(U) Program Plans:
- Develop aerodynamic models and control logic.
- Conduct flight experiments with scaled aircraft.
- Correlate computer models with experimental data.
- Design and build prototype systems.

	FY 2005	FY 2006	FY 2007
Macaw	0.000	5.570	6.469

(U) The goal of the Macaw program is to develop a helicopter emulator system carried on a small UAV. The system would provide acoustic and thermal (infrared) emulation of a variety of helicopters. Macaw could be used for mine clearing/route determination as well as escort missions. The system would draw fire from ground based adversaries, and relay the information back to the operator for off-board location and prosecution. The Macaw system would protect Army and SOCOM helicopters from ground fire, small arms, rocket-propelled grenades (RPGs), man-portable air defense systems (MANPADS), and anti-helicopter mines.

(U) Program Plans:
- Model the acoustic and thermal (IR) signatures of common helicopters.
- Develop concepts to characterize common helicopter acoustic and thermal (IR) signatures.
- Select and integrate sensor and UAV.
- Conduct field tests to determine system capability against potential threats.

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	FY 2005	FY 2006	FY 2007
Distributed Embedded Propulsion	0.000	0.000	6.000

(U) The Distributed Embedded Propulsion project will explore fully integrated engine/wing designs to take maximum advantage of a fully coupled engine/wing system. It is expected that distribution propulsive flow over the wing surface would allow circulation control on the wing through both suction and tangential blowing. Circulation control on the wing provided by the embedded distributed propulsion systems would provide unprecedented maximum lift coefficients, with associated reduction in takeoff and landing distance. Military transition targets would be short takeoff and landing airlift and transport vehicles, benefiting from improvements possible in takeoff and landing distance, as well as innovative concepts such as high aspect ratio flying wings. The program will conduct a series of design, sizing and demonstration efforts, culminating in either a wind tunnel or flight test of a circulation control wing using distributed propulsion, and/or a ground or flight test of a distributed embedded propulsion system.

(U) Program Plans:
- Conduct trade studies on aircraft sizing.
- Evaluate conceptual designs of distributed embedded propulsion concepts.
- Determine engine requirements for distributed propulsion system.
- Initiate design of distributed embedded propulsion experiments.

	FY 2005	FY 2006	FY 2007
Laminar Flow Flight Demonstration	0.000	0.000	4.200

(U) The Laminar Flow Flight Demonstration effort will explore the development of an extended laminar flow wing at both subsonic and supersonic operating conditions, with the potential for a drag reduction of up to 25% compared to a typical fully turbulent wing. Crossflow instabilities dominate the transition process for swept wings. Recent advances in theoretical understanding of the crossflow receptivity and transition process have led to innovative, passive control concepts for the crossflow transition process. Test facilities are not available to

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demonstrate this flight concept in a quiet flow environment at Reynolds numbers and Mach numbers. Flight testing a swept wing laminar flow control concept appears to be the most direct route to validation of this technology, enabling future aircraft designs to adopt passive crossflow control devices as a proven technology.

(U) Program Plans:
- Conduct feasibility study of high Reynolds number flight test.
- Initiate design of flight test experiment.
- Initiate design of laminar flow wing for demonstration.

	FY 2005	FY 2006	FY 2007
Long Endurance Autonomous Powered Powerfoil (LEAPP)	0.000	0.000	1.500

(U) The goal of the Long Endurance Autonomous Powered Powerfoil (LEAPP) program is to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to perform precision airdrop for payloads of approximately 200 lbs over long range. The enabling technologies are precision guidance, autonomous operations, and parafoil aerodynamic performance. A LEAPP system will provide Special Forces with an order of magnitude improvement in precision airdrop along with a 100 percent improvement in range and endurance. In addition, the LEAPP will have flexibility to be deployed rapidly and will be affordable based on modular system design and construction.

(U) Program Plans:
- Develop LEAPP preliminary design, risk management plan, and technology and system maturation plan.
- Conduct system trades, effectiveness, and affordability through modeling and simulation and perform system level tests for specific missions.

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	FY 2005	FY 2006	FY 2007
Propulsive Anti-Torque System (PATS)	0.000	0.000	2.550

(U) The goal of the Propulsive Anti-Torque System (PATS) program is to design, develop, integrate and demonstrate a novel propulsive anti-torque system that significantly increases the performance and survivability of rotorcraft. PATS will enable more efficient use of engine horsepower and transmission capabilities providing increased speed, a significant decrease in signatures, and elimination of the tail rotor. PATS will be demonstrated on the United States Marine Corps AH-1Z Super Cobra attack helicopter utilizing the existing AH-1Z engines, transmission, and airframe.

(U) Program Plans:
- Design and fabricate the AH-1Z PATS ground test demonstrator.
- Complete ground demonstrations.
- Validate PATS controls and obtain air worthiness release.
- Conduct flight test demonstrations and validate performance estimates.

	FY 2005	FY 2006	FY 2007
Tethered Urban Airborne Node (TETURAN)	0.000	0.000	2.000

(U) The goal of the Tethered Urban Airborne Node (TETURAN) program is to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to develop a combat vehicle launched tethered ducted fan UAV which can operate in the vertical confines and canyons of the urban environment. The purpose of the vehicle is to carry three specific types of elevated payloads: communications relay and router nodes, GPS pseudolites, and imaging sensor payloads. The purpose of the program is to three-fold: (1) design, develop, build and test the airframe, (2) design, develop, integrate and test the GPS pseudolites, and (3) to integrate and test state of the art communications nodes and imaging sensors. Technical foci of the program include high power photovoltaics enabled by tethered laser illumination, in hub ring electric motors for ducted fan propulsion, multiwavelength fiber tethers for simultaneous data and power transmission use, and GPS pseudolite

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miniaturization. Payload mass fraction for TETURAN should be high and it is expected that a modular payload of five pounds should be reasonable to achieve.

(U) Program Plans:
- Conduct preliminary system design.
- Design, develop and build tethered ducted fan airframe and control system.
- Design, develop and test ring based fan electric motors.
- Develop and test dual mode fibers – power transmission and data comms.
- Validate photovoltaics for on board power generation.
- Conduct military experimentation to validate CONOPS.

(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
Network Centric Enabling Technology TT-13	56.341	66.761	81.151	117.259	121.328	126.458	111.258

(U) Mission Description:

(U) This project provides technology to build mission applications explicitly tailored to exploit the features of network-centric system architectures. Mission applications include signal processing, detection, tracking, identification, situation understanding, planning, and control functions. These applications will integrate: (1) external sensors and processors that provide data on targets and mission contexts; (2) external platforms, both air and surface, that deliver sensors and munitions to designated areas; (3) intelligence processing systems at all levels of command; and (4) external communications networks that provide connectivity between computing nodes located on the platforms, at field command centers, and headquarters. The mission applications share data to form consistent battlespace understanding tailored to the needs of commanders at each node. The types of tailoring include common operational pictures, timelines, and resource usage descriptions. The mission applications also negotiate plans for future operations based on mission needs presented at each node. To maintain focus on operationally relevant problems, the project's technical goals are posed and evaluated in the context of mixed manned/unmanned forces.

(U) Technologies developed in this project enable localized and distributed collaborative processing. This allows networks of sensors to rapidly adapt to changing force mixes, communications connectivity, and mission objectives. The technology developed permits the distributed command and intelligence systems to effectively collaborate in a dynamic environment. Technologies are demonstrated and evaluated in the laboratory and in hardware-in-the-loop demonstrations. Demonstrations employ both stationary and autonomous mobile platforms. Operational benefits are: (1) smaller forward deployment of image and signal analysts in complex operating conditions including urban battlefields; (2) deeper understanding of the evolving stability and support operational environment; (3) consistent integration of target and environment information; and (4) flexible operational tactics and procedures to find evasive targets in difficult environments.

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(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Networked Embedded Systems Technology (NEST)	9.255	6.000	6.000

(U) The Networked Embedded Systems Technology (NEST) program provides robust coordination and synthesis services for sensor network systems. NEST is the key software building block needed to enable ad-hoc or structured wireless sensor networks to function together. Applications of these systems include: localization of snipers by collaborative sensor fusion in real time (i.e., within two seconds), sensor network-based tripwires and chokepoints for detection and discrimination of personnel and vehicles, and wide-area, 24/7 surveillance of long linear structures, (i.e., pipelines and borders). These applications require from tens to tens of thousands of nodes. NEST produces reusable software libraries and design tools that simplify the development of wireless sensor network applications. NEST is planned for transition to the U.S. Special Operations Command, U.S. Southern Command, and the U.S. Army.

(U) In particular, this technology is being combined with an active exciter to develop a radar-like sensor system to measure human activity inside buildings. The approach exploits existing wiring networks (power) to provide persistent surveillance of buildings and below grade areas. The concept is to insert radar pulses into a building's main power feed and read pulse returns from a wireless network of sensors placed around the building. The building's own wiring network serves as a transmission line to conduct these pulses throughout a structure, and every outlet or switch serves as an antenna to couple these radar waves to and from free-space.

(U) Program Plans:

- Designed deterministic and probabilistic methods for self-stabilizing protocols for lightweight coordination services, such as global clock synchronization and/or sensor localization.
- Developed design tools for the customization of coordination-services to specific applications based on requirements and platform characteristics.
- Developed formal modeling and verification techniques for coordination and integration.

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- Develop tools for the automatic composition and verification of application-specific coordination service packages; demonstrate the utility of these tools in a fully integrated system consisting of a large network of heterogeneous sensors.
- Develop tools for remotely reprogramming large scale sensor networks and services for authentication and data encryption in those networks.
- Develop and populate a repository of customizable/adaptable services for real-time coordination and synthesis that support military applications.
- Develop prototype pulsing and sensing system to measure phenomenology, insertion losses, and radiation efficiency.
- Demonstrate, in non-real time experiments, target localization and tracking in a realistic multi-story urban structure.
- Conduct final field experiments and Military Utility Assessments.

	FY 2005	FY 2006	FY 2007
Combat Zones That See (CZTS)	8.213	7.436	5.000

(U) The Combat Zones That See (CZTS) project will improve the situational awareness, effectiveness and force protection of U.S. military forces in foreign urban environments (e.g., Baghdad). CZTS will provide close-in sensing and extended reconnaissance capabilities using a network of video sensors. The system will track vehicles over wide urban areas using sparse arrays of video cameras and automatically detect vehicles that may be involved in hostile activities based on the observed tracks. This network will produce an extreme amount of data for human analysis, so advanced video understanding algorithms embedded in commercial-off-the-shelf hardware systems will monitor video feeds automatically. Reconnaissance, intelligence, and targeting information needed to provide close-in, 24/7 support for military operations in urban terrain (MOUT) will then be generated. CZTS will enable vehicle identification with a 10,000-fold reduction in the bandwidth required to transmit key data across the camera network and will provide the capability to track vehicles non-continuously across extended distances. The CZTS goal is to demonstrate technology packaged into a flexible ground-deployed system.

(U) Program Plans:

- Develop, install overseas, and evaluate a force protection prototype that employs approximately 30 cameras.
- Demonstrate sustained tracking of individual vehicles using sensors whose fields-of-view do not overlap.

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- Use vehicle track data to calibrate cameras, learn patterns of activity, and retrieve similar or related events from a track database.
- Employ motion-pattern analysis to assist in finding common elements among collected tracks.
- Develop techniques to optimize the location and orientation for emplacing cameras.
- Develop methodologies for the efficient and timely management of the video network.
- Develop, install, and evaluate a rapid deployment prototype using approximately 100 rapidly deployed cameras.

	FY 2005	FY 2006	FY 2007
Automated Battle Management	12.800	13.723	20.400

(U) The pace of battle will continue to increase as capable platforms and effective communication networks become operational. While experienced commanders are required to formulate strategy and select tactics, the increased operational tempo will demand more automation of low-level decision processes, such as route-finding, weapon/target pairing, and sensor scheduling. Some elements of these processes, such as collision avoidance and navigation, will be embedded in each platform. However, groups of platforms will be able to execute cooperative tactics to achieve coordinated effects. This cross-platform coordination and synchronization requires new technologies that can carry out aggregate maneuvers and tasks, while leveraging the functions embedded in each platform. This program is developing novel technologies for multi-platform, automated battle management at the tactical level, in the air, on the ground, and within mobile sensor networks.

- The Collaborative Networked Autonomous Vehicles (CNAV) (formerly Mission Driven Control of Autonomous Robotic Systems) program will develop autonomous control methods to cause distributed platforms (Unmanned Undersea Vehicles - UUVs) to self-organize and distribute tasks through judicious transactions conveyed over a shared communications network. The CNAV Program will illustrate these capabilities through development of a capability for submerged target Intelligence, Surveillance, and Reconnaissance (ISR) in restrictive littoral waters. CNAV will provide this capability by creating a field of dozens or hundreds of UUVs, networked through Low Probability of Interception/Low Probability of Detection (LPI/LPD) acoustic wireless communications and working collaboratively and autonomously to detect, classify, localize and track target submarines transiting the field. The field will be self-organizing and self-healing and will have the capability to close on submerged targets. The CNAV field will also be self-re-organizing, adapting to changes in environmental and operational conditions. A reach-back capability will allow reporting of field health and will enable high-level orders

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and control functions to be provided to the field. CNAV will also result in a significant reduction in the cost per square mile for submerged target ISR in the littoral domain.

- The Organic Sensor Exploitation Network (OSEN) program will develop rapid, highly autonomous techniques for sensor exploitation by leveraging technology from the NEST program to support autonomous sensor networks in ground warfare. The goal of OSEN is to provide network-enabling technology for processes currently performed at centralized ground stations and analysis centers. The objective is to move processing closer to the sensor to reduce the need for expensive communications back to a central site and provide robustness to unexpected loss of platforms, communications disruptions, and unpredictable target behavior. OSEN is developing technology to: (1) permit on-board exploitation of sensor data from remotely deployed sensor nodes; (2) support correlation of information developed across different platforms; (3) detect, track, and identify targets in the field-of-view of a platform; (4) cue other sensors to acquire a target; and (5) transition targets to other platforms as different targets move through sensor fields-of-view. OSEN system studies will evaluate the relative value of different sensor mixes against low-flying aircraft, ground vehicles, dismounted infantry, and irregular forces. Sensor candidates include: electro-optical, infrared, radar, passive RF, acoustic, seismic, and magnetics which may be fixed or mounted on mobile platforms. The program accommodates variable communications connectivity; models predict changes caused by line-of-sight occlusions.

(U) Program Plans:

– Collaborative Networked Autonomous Vehicles (CNAV)
  -- Develop secure, robust underwater wireless communications and networking.
  -- Perform intelligent routing of threat characteristic and track data through the field to alert CNAV nodes down stream to position or reposition for target pursuit and intercept.
  -- Demonstrate fully autonomous and collaborative CNAV field deployment, autonomous field set-up and self-localization, distributed common tactical operational picture, self-healing and reconfiguration, and threat pursuit and interception.
  -- Demonstrate collaborative automated target detection, classification, localization and tracking (DCLT).

– Organic Sensor Exploitation Networks (OSEN)
  -- Define representative sensor mixes and operational scenarios.
  -- Perform analytical trade studies to generate representative sensor network components and tactics.

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-- Develop a network node architecture adaptable to the devices present at that node.
-- Prototype candidate algorithms for each function (search, detect, track, identify, correlation, hand off) based on alternative technologies.
-- Evaluate candidate algorithms in a synthetic environment to calibrate and verify performance models.
-- Insert selected algorithms into a hardware-in-the-loop testbed; demonstrate practical utility and verify system performance.

	FY 2005	FY 2006	FY 2007
Urban Warfare Robotic Surveillance (URS)	3.554	4.605	7.444

(U) The Urban Warfare Robotic Surveillance System (URS) program will develop new mobile sensor systems, carried on both long-endurance ground and short-endurance air platforms, to support warfighter operations in constrained urban environments. URS is exploring a mix of sensor technologies (Electro-Optical/ Infrared video, active optics, radar, acoustic, magnetic, chemical, and RF direction finding). Sensors are being tested in environments characterized by complex multi-path propagation, limited lines-of-sight, and frequent obscuration. Platforms and sensor networks will be designed to operate in urban exterior, underground, and indoor environments. Communications repeaters and routers will be included for terrestrial connectivity to all platforms that also provide for autonomous operation if communications are interrupted. The program includes means to resupply fuel and power to forward-deployed platforms. A program demonstration will deliver a prototype robotic squad that will provide integrated urban surveillance to augment or replace dismounted infantry in dangerous operations. URS missions include route clearing, flank protection, tunnel clearing, and scout and peacekeeping operations in urban environments.

(U) Program Plans:
- Select a baseline set of sensors, data links, and platforms.
- Design a flexible physical and logical architecture for a baseline URS system.
- Derive tasks and functions from standard urban reconnaissance operations plans.
- Construct a software testbed where candidate system components can be exercised in a synthetic urban battlespace.
- Develop alternative sensor models and algorithms (signal processing, object detection, object recognition, mapping, correlation, tracking, and route generation and communications management).

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- Compare alternatives in the synthetic testbed. Select combinations that offer the most robust and effective performance.
- Build a hardware testbed incorporating selected component sensors and algorithms.
- Exercise test platforms in a series of increasingly difficult mission/environment combinations.
- Improve sensors or algorithms that limit performance.

	FY 2005	FY 2006	FY 2007
Home Field	10.500	12.652	15.200

(U) The Home Field program will develop networked video and Laser Detection and Ranging (LADAR) processing technology that rapidly and reliably updates a 3D model of an urban area. It will provide 3D situational awareness with sufficient detail and accuracy to remove the "home field advantage" enjoyed by opponents. Detailed mobility maps to support ground vehicle routing will be inferred and generated, and detailed visibility data to support sensor positioning will then be derived to maximize coverage and minimize detectability. High fidelity baselines will be created to support change detection to cue searches for targets and anticipate changes due to current or impending meteorological events. The program will supply real-time context information to sensor managers, maneuver controllers, weapons operators, and commanders. Furthermore, the program will filter natural change from artificial change indicative of human (threat) activity and permit operation of military forces in hostile terrain normally deemed favorable to opponents because of their historical familiarity with hide points, sight lines, and mobility characteristics.

(U) A key part of Home Field is the development of large format re-writable holographic displays for urban terrain. Initially a 1' x 1' rewritable display will involve the adaptation and engineering of organic photorefractive polymer for a hogel-based display prototype. Home Field will conduct investigations in preparation for specification generation, to include alternative methods to coat very large substrates, illumination and light source alternatives like emitter matrix that can be scaled, and issues critical to parallel writing, such as intensity balancing, interleaving, and mechanical packing. This effort will culminate in the world's first full-motion hologram.

(U) Program Plans:

- Demonstrate a 3D-model method that uses distributed video and LADAR cameras in a mixed urban environment.
- Demonstrate the ability to extract architectural features, such as windows and doors, from close-in imagery.

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- Demonstrate an effective man-machine interface to edit/update the extracted features.
- Demonstrate a model update approach that keeps the urban cartographic representation current.
- Demonstrate rewritable holograms, large format (6' x 6') holograms, and a video-rate hologram.

	FY 2005	FY 2006	FY 2007
Adaptive Reflective Middleware Systems (ARMS)	5.800	6.120	8.860

(U) The Adaptive and Reflective Middleware Systems (ARMS) program is developing an integrated open system computing and information architecture. The initial focus is on the Total Ship Computing Environment (TSCE) in the DD(X) Future Surface Combatant Family of Ships; however, the technology is applicable to other network-centric DoD systems. The TSCE executes all tasks and mission applications optimized at the platform level, rather than the subsystem level. Autonomous TSCE systems require middleware and frameworks that adapt robustly to changes in environmental conditions. ARMS middleware coordinates the exchange of information predictably, scalably, dependably, and securely among shipboard entities by employing advanced Quality of Service (QoS) capabilities of the underlying network and end systems.

(U) Program Plans:

- Define and prototype algorithms, adaptive protocols, patterns, and technologies.
- Develop technologies to enable the use of the Java programming language in time-critical applications.
- Enforce security policies to enhance and support secure resource allocation, scheduling, and control; ensure stability and dependability across the network-centric TSCE.
- Develop robust meta-programming policies and mechanisms based on standards-based middleware.
- Define and prototype reflective techniques for synthesizing optimized distributed, real-time, and embedded middleware.
- Develop required information models, algorithms, and technologies; develop technologies to configure customizable, standards-compliant TSCE middleware and applications.
- Develop robust adaptive protocols, algorithms, patterns, and technologies that exploit standards-compliant middleware.

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- Develop and capture design expertise in information models. Formalize the successful techniques and constraints associated with building, generating, and validating QoS-enabled, middleware frameworks and protocol/service components for the DD(X) TSCE baselines.
- Demonstrate mature, standards-based middleware technologies for transition to the DD(X) Surface Combatant Family of Ships.

	FY 2005	FY 2006	FY 2007
Pre-Conflict Anticipation and Shaping (PCAS)	0.000	5.825	6.247

(U) The Pre-Conflict Anticipation and Shaping (PCAS) program develops and integrates a range of technologies into a unified system for supporting Theater Security Cooperation (TSC). PCAS technologies include quantitative and computational social science modeling and simulation, scenario generation, ontological modeling of security problems, advanced interactive visualization techniques, and agent-based programming. When integrated, these technologies and models allow combatant commanders and senior decision makers to understand and anticipate the societal/regional indicators that precipitate instability and conflict within an area of responsibility in time intervals ranging from six months to five years, then mitigate the impact of that instability by recommending shaping actions (military, Non Government Organizations (NGO), State, U.S. Agency for International Development (USAID), private companies) that address the causal factors of the instability. PCAS will help Combatant Command (COCOM) staffs identify unintended consequences of actions taken to influence or remediate situations and assist in the assessment of secondary/tertiary effects of actions, possibly delayed weeks, months, or years in time, that could have positive or negative effects on U.S. goals and objectives within countries and regions. The PCAS system will be tested and validated against current state-of-the-art practices, such as intelligence analysis reports that provide counsel about an area of operations using idiosyncratic mental models and research from open source and classified materials.

(U) Program Plans:

- Augment the suite of social science models with emerging computational social science model and theories that can be applied to assess and predict social change.
- Select a representative set of countries and regions in Pacific Command (PACOM) which are expected to range from stable to highly unstable social dynamics.
- Obtain and organize a large corpus of data describing the selected countries and regions that is useful to the models.

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- Build tools to automatically translate the data corpus into a form usable by the suite of quantitative and computational social science models.
- Build prototypes of software tools based on the identified social science theories and methodologies.
- Conduct regular experiments comparing predictions of the identified techniques with real-world events in an operational environment.
- Make rugged and operational the remaining techniques to form tools that can be transitioned to the staff at Combatant Commands (PACOM HQ).
- Demonstrated utility of models based on system dynamics, scaling laws, agent-based modeling, parametric search, and differential regressive equations to assess stability of two countries.

	FY 2005	FY 2006	FY 2007
Diagnostic Network Economies	0.000	6.000	6.000

(U) The Diagnostic Network Economies Program will obtain orders of magnitude improvement in the speed, accuracy, and efficiency of fault diagnosis in distributed systems that provide support for crucial network centric military operations, such as transmitting a common operational picture and maintaining information dominance. As network centric warfare systems are introduced, the management systems that are needed to operate these networks must become exceptionally robust. The Diagnostic Network Economies program will substantially reduce the risks associated with network-centric operations, and at the same time assure the agility of U. S. forces by developing effective network fault diagnosis capabilities that minimize the logistical footprint associated with that aspect of network management and reduce the opportunities for human error in the process.

(U) Program Plans:

- Develop techniques for optimizing the overhead of information collection in limited-bandwidth environments.
- Improve current capabilities to share diagnostic information appropriately and securely across multilevel security boundaries.
- Leverage and extend the available techniques for information fusion across multiple data sources, and anomaly detection.
- Distribute diagnostic capabilities without centralized points of failure.
- Explore new approaches to reasoning in the presence of partial and unreliable information.

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– Employ new approaches to discover and maintain dependencies within network centric warfare systems.

	FY 2005	FY 2006	FY 2007
Total Operating Picture Visualization and Understanding (TOPV&U)	0.000	0.000	6.000

(U) Effective operations require that Commanders have a decisive understanding of the operational environment. Effects-based Operations and the advent of asymmetric warfare have increased the amount, complexity, and scope of the information required to achieve that understanding. The Total Operating Picture Visualization and Understanding (TOPV&U) program will develop technologies for managing the complex streams of information describing modern conflicts. It will develop new technologies to: catalog, correlate and fuse these new forms of information into patterns; detect the presence of inaccuracy, inconsistency, incompleteness, uncertainty, ambiguity, and deception; and construct graphical and audio portrayals of the information to change human cognition and enable the commander to achieve a deeper and more complete understanding of the situation with a minimum of cognitive involvement. These technologies will enable commanders to gain a shared visualization and understanding (not just an awareness) of the total situation; not only the military situation but also the diplomatic, political, economic, social, information distribution and infrastructure situations as they affect military operations. The transition point and partner will be the Joint Forces Command. The program will include experimentation using live information feeds to determine the utility of the technologies when employed by experienced analysts and commanders.

(U) Program Plans:

– Develop new fusion technologies to correlate and fuse non-traditional forms of information into patterns.
– Detect the presence of inaccuracy, inconsistency, incompleteness, uncertainty, ambiguity, and deception.
– Develop and demonstrate the use of non-physics-based models of an adversarial coalition's various political, social, economic, information dissemination and service infrastructure systems as well as its military or insurgent capabilities, as a means to organize, associate and correlate data points, and to forecast future activity.
– Develop and demonstrate graphical and audio transformations that generate portrayals of complex, multi-dimensional information which can exploit the potency of human cognition and enable the commander to achieve a deeper and more complete understanding of the situation with a minimum of cognitive involvement.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

	FY 2005	FY 2006	FY 2007
Eyes-On System	3.669	0.000	0.000

(U) The Eyes-On (EyO) System program developed multifunctional information gathering capability for an air launched micro-Unmanned Air Vehicle (micro-UAV). EyO employs very high-resolution, commercial off-the-shelf, electro-optical/infrared sensors integrated into a low-signature sensing platform. Commanders can employ the system to achieve visual human-in-the-loop confirmation of targets by going close-in and under-weather. Presurveying the engagement zone for collateral damage avoidance will support go/no-go attack decisions under restrictive rules of engagement. A limited loitering capability allows Eyes-On to support real-time bomb damage assessment following an attack. EyO utilizes line-of-sight RF communications and local command and control system technologies to deliver exquisite just-in-time visual confirmation to the warfighter. The program has developed the capability to support discrimination between non-combatants and combatants. As a forward-deployed, loitering, micro-robotic forward area controller, EyO could support long range weapon delivery by monitoring the target area throughout the weapon flyout. EyO adapted existing sensor and platform designs and fabricated prototype small UAVs in prototype quantities. Each prototype consists of the air vehicle, a sensor package, flight control system, and data link to the launch platform.

(U) Program Plans:

- Defined system architecture to include command and control requirements.
- Analyzed tradeoffs between sensing performance, target location and referencing designs, data rates, and smart processing aboard the small UAV.
- Developed candidate designs at different points on these trade-off curves.
- Simulated each design over a suite of missions and selected the design that provided the best overall actionable-ID capability.
- Installed the brassboard and selected sensor, signal processing, flight control and data link software on a recoverable test platform.
- Constructed and tested entire prototype systems.

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	FY 2005	FY 2006	FY 2007
Enhancement of Communications and Telemetry Support	0.000	1.700	0.000

(U) Select and fund initiatives for the enhancement of communications and telemetry support.

	FY 2005	FY 2006	FY 2007
MESH-Enabled Architecture	0.000	1.000	0.000

(U) Select and fund initiatives for MESH-enabled architecture.

	FY 2005	FY 2006	FY 2007
R31 Systems: Next Generation of Intelligent Comm.	0.000	1.700	0.000

(U) Select and fund initiatives for the next generation of intelligent communications.

	FY 2005	FY 2006	FY 2007
NASEC Through Wall Radar Imaging	2.550	0.000	0.000

(U) Continued work at the National Applied Software Engineering Center (NASEC) to design, build and utilize an experimental radar to support advances in thru-wall sensing at radio frequencies.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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