RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research				R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	337.210	359.936	374.717	436.842	475.935	482.565	508.987	522.565
Naval Warfare Technology TT-03	44.116	38.015	26.676	35.440	45.490	45.490	45.490	45.490
Advanced Land Systems Technology TT-04	62.491	72.221	71.466	84.509	86.979	93.809	93.809	93.809
Advanced Tactical Technology TT-06	111.199	111.706	127.550	136.351	145.256	145.256	145.256	145.256
Aeronautics Technology TT-07	59.179	69.927	76.326	98.576	105.752	105.752	132.174	145.752
Network Centric Enabling Technology TT-13	60.225	68.067	72.699	81.966	92.458	92.258	92.258	92.258

(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 Surface Warfare Automated Shiphandling program will develop technologies to increase survivability and operational effectiveness of small and medium surface vessels in rough seas. 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. 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E

(U) The Advanced Land Systems 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.

(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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E

(U) **Program Change Summary:** *(In Millions)*	**FY 2006**	**FY 2007**	**FY 2008**	**FY 2009**
Previous President's Budget	346.076	383.680	448.165	493.591
Current Budget	337.210	359.936	374.717	436.842
Total Adjustment	-8.866	-23.744	-73.448	-56.749
Congressional program reductions	0.000	-36.224		
Congressional increases	0.000	12.480		
Reprogrammings	0.000			
SBIR/STTR transfer	-8.866			

(U) Change Summary Explanation:

FY 2006	Decrease reflects the SBIR/STTR transfer.
FY 2007	Decrease reflects a PE execution adjustment, congressional program reductions, reductions for Sections 8023 and 8106, offset by congressional adds for CEROS, hypersonics, hazardous materials detection, optical sensor systems, extreme light sources, and NASEC.
FY 2008/09	Decreases reflect programs ending or transitioning in Naval Warfare Technology (HyFly, Hedlight, SWASH), Advanced Land Systems Technology (NetEx, Sticky Flares), Aeronautics Technology (Hypersonics Demonstration), and rephasing of Network Centric programs.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03					
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Naval Warfare Technology TT-03	44.116	38.015	26.676	35.440	45.490	45.490	45.490	45.490

(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 2006	FY 2007	FY 2008	FY 2009
Friction Drag Reduction	7.289	5.125	3.700	2.635

(U) The Friction Drag Reduction program will develop and demonstrate physics-based, engineering design tools that will predict additive-based friction drag reduction on Navy surface ships. 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 how turbulent flows are modified by the presence of polymers and air injection. These models were validated with small-scale physical experiments and tests in a large scale facility at ship-relevant scales. The predictive capability has been tested using an optimized injector in a blind-test of the design tool in large scale experiments conducted on a 13 meter long flat plate at the U.S. Navy's William B. Morgan Large Cavitation Channel, with separate tests for the polymer and air injection. Additionally, polymer and air film injection was tested to simulate the surface roughness that would be caused by biofouling of surface vessel hulls. These large-scale predictive models and tests 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).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

(U) Program Plans:
- Verified predictive capabilities of air and polymer injection models.
- Experimentally determined how additive-based friction drag reduction is influenced by the presence of significant surface roughness.
- Evaluate concepts for a realistic at-sea test using additive-based drag reduction technology.
- Conduct initial design at-sea demonstration to evaluate sea states, maneuvering conditions, biofouling, ship curvature and pressure gradients on injection based drag reduction approaches.
- Determine how drag reduction and air film onset scales with speed of vessel in at-sea demonstrations.

	FY 2006	FY 2007	FY 2008	FY 2009
Surface Warfare Automated Shiphandling (SWASH)	2.800	2.728	0.000	0.000

(U) The Surface Warfare Automated Shiphandling (SWASH) program is developing and demonstrating 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 is seeking to enable safe operations in an expanded sea state envelope by combining detailed wave sensing and prediction with improved understanding of vessel dynamics in a control system that provides optimum course and speed to the vessel's rudder and engines. SWASH technology offers the potential to reduce injuries to crew and passengers as well as damage to vessels caused by high waves and represents an enabling technology for unmanned surface vessels (USVs) by increasing survivability, recoverability and operability.

(U) Program Plans:
- Refine prediction capability for ocean wave fields.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

	FY 2006	FY 2007	FY 2008	FY 2009
Hypersonics Flight Demonstration (HyFly)	11.882	5.476	0.000	0.000

(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.

(U) Program Plans:

- Conducted captive carry, drop, boost performance and boost separation flight tests.
- Performed vehicle subsystems verification testing.
- Conduct flight weight vehicle environmental testing.
- Conduct flight weight engine component durability testing in operating engine environment.
- Conduct initial, low flight Mach (~Mach 4.0) flight-testing.
- Demonstrate Mach 6.0 cruise and extended range (400 nm).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

	FY 2006	FY 2007	FY 2008	FY 2009
High Efficiency Distributed Lighting (HEDLight)	2.354	1.000	0.000	0.000

(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. A Memorandum of Agreement (MOA) is in place to transition this technology to the Navy. An adjunct to the HEDLight program developed and demonstrated a state-of-art Assault Zone Landing Light, which solved the logistics and reliability issues of currently deployed lights.

(U) Program Plans:

- Developed high efficiency full-spectrum light sources.
- Developed high efficiency optical coupling mechanisms.
- Developed high efficiency fiber-luminaries for distributed light transport.
- Developed an integrated high efficiency distributed lighting illuminator.
- Demonstrate a limited scale HEDLight system installed on a U.S. Navy ship.
- Developed and demonstrated the L-32 Assault Zone Landing (AZL-15) Lights, meeting the minimum lighting (visible and IR) and battery duration requirements and tested all system variations under operational field conditions.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

	FY 2006	FY 2007	FY 2008	FY 2009
Center of Excellence for Research in Ocean Sciences (CEROS)	6.250	5.600	0.000	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 potential Department of Navy transition partners. Major research areas of interest have included shallow water surveillance technologies, sensor communications, 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.

	FY 2006	FY 2007	FY 2008	FY 2009
Acoustic Arrays for Torpedo Defense	0.760	2.000	1.306	0.000

(U) 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:
- Designed, developed, and tested a two transducer module.
- Completed design improvements on second generation transducer module.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

- Successfully tested second generation transducer module.
- Develop scaled prototype transducer array.
- Conduct prototype system testing.

	FY 2006	FY 2007	FY 2008	FY 2009
Unique Propulsion Techniques	1.238	3.273	1.000	1.200

(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. The propulsion mechanism of the electric eel may hold the key to this enabling technology. 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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

	FY 2006	FY 2007	FY 2008	FY 2009
Riverine Crawler Underwater Vehicle	2.458	2.613	2.500	1.500

(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) This program will explore the potential concepts and the technologies necessary 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.

	FY 2006	FY 2007	FY 2008	FY 2009
Fast Boat (formerly Small Craft Advanced Hydrodynamic Design)	3.085	0.000	0.000	0.000

(U) The goal of the Fast Boat program was to design, and demonstrate one or more boats with threshold speeds of 60 knots and an objective speed of 100 knots in high sea states with a ride quality that is a significant improvement over existing boats.

(U) The program addressed design requirements for both high speed and good ride quality in sea states 3-5 and investigated the operational benefit of high speed in special operations.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

(U) Program Plans:
- Completed system trade studies and preliminary design.

	FY 2006	FY 2007	FY 2008	FY 2009
Super-Fast Submerged Transport (formerly Underwater Express)	6.000	8.000	12.100	21.000

(U) The Super-Fast Submerged Transport (formerly Underwater Express) program will explore the application of supercavitation technology to underwater vehicles, enabling high speed transport of personnel and/or supplies. The inherent advantages of traveling underwater are: the 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 drag due to fluid viscosity is reduced by orders of magnitude, thus reducing the power requirement dramatically. This program will use modeling, simulation, and experiments and testing to develop the understanding of the physical phenomena associated with supercavitation and the application to underwater vehicles. Innovative failsafe controls will be required for stability and maneuverability at speed. Elements of the Fast Boat program have been incorporated in the Underwater Express program.

(U) Program Plans:
- Develop models and simulations to predict cavity and cavitator performance.
- Conduct subscale experimentation and testing in a controlled facility.
- Conduct subscale experimentation and testing for system stability and control.
- Design, fabricate and test a scaled prototype vehicle.
- Analyze prototype performance for speed, power, and stability. Develop vehicle and cavity scaling relationships.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

	FY 2006	FY 2007	FY 2008	FY 2009
Wideview	0.000	2.200	3.500	3.500

(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.

(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.

	FY 2006	FY 2007	FY 2008	FY 2009
Distortion-free Seeing Through the Air/Water Interface	0.000	0.000	2.570	5.605

(U) Images seen through an air-water interface are distorted by multiple refractions from the water surface. This program will develop and demonstrate high resolution imaging and image exploitation technology to provide new capabilities for detection and discrimination of objects such as mines. This effort, if successful, could significantly improve near-surface operations and safety. Transition will be focused on Navy Special Warfare forces.

(U) Program Plans:
- Conduct experiments and scale testing of imaging algorithms.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-03

- Develop imaging system, characterize resolution, image quality, and performance in various water qualities.
- Design, develop, and test a prototype system.

(U) Other Program Funding Summary Cost:

Hypersonics Flight Demonstration	FY 2006	FY 2007	FY 2008	FY 2009
PE 0602114N, PE 0603114N, PE 0603123N, Navy, Office of Naval Research	11.300	2.200	0.000	0.000

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE: February 2007	
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA2 Applied Research				R-1 ITEM NOMENCLATURE: Tactical Technology; PE 0602702E, Project TT-04				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Advanced Land Systems Technology TT-04	62.491	72.221	71.466	84.509	86.979	93.809	93.809	93.809

(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); Maneuver and Control on the Urban Battlefield, Advanced Vehicle Survivability (AVES), Turbo-Compounded Rotary (TCR), Recognize Improvised Explosive Devices and Report (RIEDAR), Lightweight Ceramic Armor (LCA), Small Combat Vehicle with Robotic Automation, Army Hypersonic Advanced Technology, Extreme Light Sources for Defense Applications, Optical Sensor System, Research on a molecular approach to HazMat Decontamination and RF Counter Sniper.

(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
Novel Sensors for Force Protection	12.237	15.992	12.313	12.438

(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.)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

typically found in urban settings. The Novel Sensors program consists of the Unique Signature Detection program (formerly known as the Odortype Detection program) and the Urban Vision program.

(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 goal of the Urban Vision program was to enable the warfighter to 'see' movers within a building using a variety of fused multi-spectral techniques. The objective was to develop a necessary and sufficient number of sensor breadboards that could 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 would be placed on the roof to give information on the number and location of occupants in the floor immediately below. The sensors had to be small and light weight. The system had to operate with a minimal number of sensors (the goal is four). Technical challenges included 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.
  - -- 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

- Urban Vision
  - -- Designed, developed, and evaluated an initial (fixed placement) multi-static multi-frequency dielectric imaging array test system.
  - -- Developed algorithms for inverting multi-static imaging data to reveal the interior structure and distribution of objects within a building, and to coarsely categorize those objects as enemy troops or combatants.

	FY 2006	FY 2007	FY 2008	FY 2009
Dynamic Optical Tags (DOTS)	9.766	7.545	3.897	0.000

(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 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 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:
- Demonstrated performance in the field at militarily useful data rates and ranges.
- Develop novel emplacement technologies.
- Develop airborne interrogation systems.
- Integrate and test components in a fully functional configuration.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

	FY 2006	FY 2007	FY 2008	FY 2009
Guided Projectiles	13.721	11.825	3.857	0.000

(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 accuracy and effectiveness of the weapons are increased and the potential for collateral damage is reduced. 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. In addition, the technology being developed for the 60mm projectile will be investigated for application to the 81mm and 120mm mortars to increase the accuracy and effectiveness of all fielded mortar rounds at a low cost.

(U) Program Plans:

- 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.
- Demonstrate guide-to-hit with circular error probability (CEP)<4m for 60mm mortar.
- Demonstrate tube launch of 60mm optically guided mortar round and optical designating system in conjunction with USMC.
- Investigate development path to transfer the 60mm technology to the 81mm and 120mm mortars.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

	FY 2006	FY 2007	FY 2008	FY 2009
Networking Extreme Environments (NetEx)	3.977	4.995	2.000	0.000

(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:
- Demonstrated a tactical voice data radio (TVDR) physical layer.
- Developed new and innovative methods of ad hoc networking and mitigating interference.
- Develop a TVDR with ranging.

	FY 2006	FY 2007	FY 2008	FY 2009
Magneto Hydrodynamic Explosive Munition (MAHEM)	5.316	3.135	4.426	4.200

(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 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

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 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:

- Complete single CMFG and MAHEM concept designs.
- Develop MAHEM variants tailored to mission-specific requirements.
- Develop and conduct experiment demonstration of a self-contained MAHEM in the form of an AT4 shoulder-mounted munition.
- Conduct aerostability, setback, and jet penetration tests on the AT4 mockup.
- Test Fire from AT4 tube to demonstrate aerostability and setback.
- Transition to munitions development centers.

	FY 2006	FY 2007	FY 2008	FY 2009
Compact Military Engines	2.065	2.430	2.370	1.356

(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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

(U) Program Plans:
- 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 2006	FY 2007	FY 2008	FY 2009
Crosshairs	7.495	10.900	14.400	17.000

(U) The Crosshairs program seeks to develop a vehicle mounted, threat detection, and countermeasure system that will detect, locate, and engage shooters, and defeat a variety of threats to include bullets, Rocket Propelled Grenades (RPGs), Anti-Tank Guided Missiles (ATGMs), and direct fired mortars, both stationary and on the move. Threat identification and localization will be accomplished in sufficient time to enable both automatic and man-in-the-loop responses. Phase I of the program focused on designing and developing the appropriate Crosshairs sensor system. Phase I culminated with a static live fire test to determine the most effective candidate sensor system. Phase II will focus on the integration of the Phase I sensors onto a military vehicle for on-the-move performance assessment. In addition, the system will be integrated and tested with a remote overhead weapon station with automatic slew to target capabilities. The weapon station will be equipped with visual and IR cameras to provide imaging for forensic and judicial evidence and rapid dissemination of location of combatants for both effective concealment, and counter fire capabilities. Integration with an appropriate active protection system for further protective measures against RPGs will be explored.

(U) The Concept of Operations is to provide a military vehicle with a mounted detection and response system that operates both stationary and on the move. Bullets will be detected and localized using the acoustic DARPA-developed Boomerang II acoustic gunfire detection system. Detection of all other threats will use the Crosscue radar developed in Phase I. Crosscue radar is a dual mode, continuous wave, and pulsed Doppler radar, which will be used to determine range, velocity, and azimuth of the incoming threat. It is envisioned that the system will provide a significantly improved capability to detect and respond to incoming threats during hostile and peacekeeping operations in both urban and non-urban environments. Technology challenges include: low false alarm rate, algorithm development, high speed sensor and data processing for 360 degree azimuth and 60 degree elevation detection zone; robust data collection to locate firing source; and fast response time. The program will culminate with a demonstration of two prototype systems in a typical combat environment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

(U) Program Plans:
- Completed Phase I.
- Identified and developed ultra-fast sensors and algorithms to detect and track multiple threats in near real time.
- Performed component testing and conducted detection and shooter localization demonstrations.
- Evaluate vehicle platform and weapon system for integration.
- Analyze data and integrate sensors and response system with appropriate on the move capabilities.
- Test system on the move against a variety of threats with integrated response systems.

	FY 2006	FY 2007	FY 2008	FY 2009
Improved Explosives	2.635	0.562	0.000	0.000

(U) The Improved Explosives program explored development of more effective explosive munitions that would deliver three to five times more power (pound-per-pound) than conventional systems. The program evaluated techniques for improving the effectiveness and efficiency of explosive energy, and considered application of such improved explosives to wall/building breaching and improvised explosive device (IED)/ordnance neutralization.

(U) Program Plans:
- Conducted initial studies, modeling and simulation to determine the feasibility of candidate technologies.

	FY 2006	FY 2007	FY 2008	FY 2009
Agile Interceptor	2.592	5.330	5.994	7.665

(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 Agile Interceptor will have the ability to maneuver very rapidly and with sufficient

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

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. Program plans will include multi-phased user reviews to ensure that the resulting products are meaningful and affordable. Evaluation of various area and platform defense options will be conducted culminating with a series of capability demonstrations in a realistic test environment.

(U) Program Plans:
- Define system architecture and constraints in conjunction with user / technical group.
- Define metrics and evaluate system effectiveness and cost.
- Develop and demonstrate critical technologies such as efficient lethality mechanisms and lightweight, integrated Guidance Navigation and Control (GNC) systems.
- 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 2006	FY 2007	FY 2008	FY 2009
Counter Improvised Explosives Laboratories (CIEL)	1.687	1.567	1.209	1.200

(U) Improvised explosives (IEs) are one of the most popular weapons 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 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 provides a clear and fast identification of the target explosive.
- Identify a physical method that will neutralize/desensitize bulk explosive materials.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

- Conduct feasibility demonstrations.
- Optimize and demonstrate the sensor.

	FY 2006	FY 2007	FY 2008	FY 2009
Maneuver and Control on the Urban Battlefield	0.000	2.500	4.300	7.850

(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.

(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.

	FY 2006	FY 2007	FY 2008	FY 2009
Advanced Vehicle Survivability (AVES)	0.000	0.000	3.500	7.800

(U) The Advanced Vehicle Survivability (AVES) program is a system demonstration of advanced survivability technologies (ASTs) on legacy fighting vehicles such as the Bradley and HMMVW. Integration of certain high-power ASTs into legacy vehicles is impossible today, but would be enabled by a new, very-thin-film battery technology. The AVES program would develop a very small integrated extreme power module

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

(IEPM) using this battery technology, and demonstrate a deployable AST system installation in live fire testing on a legacy vehicle. The IEPM system would provide high voltage (300/600V) with a pulse power capability of 20kW/module. The IEPM would enable integration of high-power ASTs into small legacy vehicles in the current inventory. Four modules are required (each is smaller than a gallon of milk), and can be mounted into any interior space available (wheel wells, under the hood, under the seats, etc.) or even external on the fenders to provide power for the AST.

(U) Program Plans:

- Develop and integrate power module components – charger, battery, and high-voltage converter.
- Test components in a laboratory environment.
- Integration and packaging of components into a power module.
- Live-fire testing of stand-alone, electromagnetic armor system.

	FY 2006	FY 2007	FY 2008	FY 2009
Turbo-Compounded Rotary (TCR)	0.000	0.000	3.200	6.700

(U) The goal of the Turbo-Compounded Rotary (TCR) Engine program is to achieve a specific fuel consumption (sfc) of 0.34 lb/hp.hr at a specific power (SP) of 3.0 hp/lb through the integration of turbo-compounding, the stratified charge rotary engine operating on a Miller Cycle, new lightweight materials, and rotary core heat loss reduction technologies. The TCR Engine program will enable a new class of both manned and unmanned air and ground vehicles. The concept offers a new approach to integrating the benefits of a rotary engine with new technologies to vastly improve engine performance. With the breakthrough improvement in sfc and SP, the TCR engine technology will enable loiter time improvements that nearly double that achieved using simple turbo-shaft powerplants. Additionally, the power density goal exceeds the current target for aero-diesel engines by 300%. Specific objectives of the TCR Engine program include: application of the Miller Cycle to a highly turbocharged rotary core; development of stratified charge combustion; analytical investigation of the benefits of high speed operation to this engine configuration; integration of high temperature cooling system; as well as investigation and test of lightweight materials in both the rotary core and turbomachinery.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

(U) Program Plans:
- Validate engine performance goals and produce a conceptual design.
- Identify and develop the critical technologies required to meet the performance goals.
- Build and demonstrate the integrated engine.

	FY 2006	FY 2007	FY 2008	FY 2009
Recognize Improvised Explosive Devices and Report (RIEDAR)	0.000	0.000	3.000	6.800

(U) The goal of the Recognize Improvised Explosive Devices and Report (RIEDAR) program is to develop and demonstrate a capability for standoff detection of improvised explosive devices. The program will leverage laser-based optical approaches to detect chemical signatures of explosives and related compounds.

(U) Program Plans:
- Prevent UV photo-degradation during laser excitation.
- Rapidly match wavelengths to interrogate molecules of interest in a specific area.
- Maintain coherent cross beam stability.
- Limit signal integration time.
- Control filament at interrogation area.

	FY 2006	FY 2007	FY 2008	FY 2009
Lightweight Ceramic Armor (LCA)	0.000	0.000	4.500	7.500

(U) The Lightweight Ceramic Armor (LCA) program will leverage recent breakthroughs in novel ceramic fabrication processes developed in the Materials Technology program element to drive a dramatic shift in the performance of body armor. Currently fielded body armor is heavy and limited in the diversity of shapes that may be molded. Its weight and bulk prohibit consideration of protecting a soldier's extremities, and its cost

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

prohibits consideration of using it to protect vehicles. Recent breakthroughs in ceramics processing technology offers the opportunity for cost effective fabrication of molded shapes, the retention of nanostructured grains for significantly higher energy dissipation, a 50% reduction in weight for equal ballistic protection, and similar cost. The focus areas of the program will be the optimization of the material composition and nanostructure for maximum protection per unit weight and cost, scale up of the fabrication technology to body armor size scale, and integration of the ceramics with packaging structures to obtain multi-strike capabilities. Given its application-specific focus, this program is now being funded in the Tactical Technology program element.

(U) Program Plans:
- Develop Lightweight Ceramic Armor with high dynamic tensile stress to effectively dissipate shock waves.
- Reduce armor thickness in order to increase soldier's agility.
- Deliver Lightweight Ceramic Armor at a cost equal or similar to current armor selection.
- Design Lightweight Ceramic Armor to provide protection to soldier's extremities.
- Conduct ballistic testing to demonstrate improved ballistic efficiency.

	FY 2006	FY 2007	FY 2008	FY 2009
Small Combat Vehicle with Robotic Automation	0.000	0.000	2.500	4.000

(U) The Small Combat Vehicle with Robotic Automation program will evaluate and design small, survivable, highly mobile ground combat vehicles that have combat firepower equivalent to today's larger ground vehicles (e.g. M2/M3 Bradley) but in a highly deployable package of five ton to ten ton with a single crew person/operator on board (with the option for operation with no crew person in an unmanned configuration). Smaller vehicle weights enable effective deployability in helicopters or C-130 aircraft for vertical envelopment. This program seeks to achieve an optimal mix of manned and unmanned technologies in a small, well protected, highly deployable combat vehicle. By utilizing automation technologies in vehicle driving and vehicle payload systems (reconnaissance sensors and weapons), a single crew person in the combat vehicle can effectively drive and operate payloads concurrently at appropriate times while still providing high-level supervisory control over all systems. At mission critical times, the crew person can be removed and supervisory control can be given off-board from a separate controlling vehicle. The key technologies that enable a Small Combat Vehicle with Robotic Operation include sensor-based autonomous & semi-autonomous navigation,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

robust indirect driving (via combinations of cameras, perception-generated views of the terrain, or teleoperation), robust supervisory semi-autonomous control and teleoperation to allow vehicle operation from another vehicle, high density low-weight armor, aided target acquisition and targeting-based remote weapons stations, effective but minimalist warfighter-machine interfaces for crew person interaction with semi-automated driving and payload systems, and high performance vehicle mobility systems (suspensions and drivetrains).

(U) Program Plans:
- Conduct initial studies and develop vehicle automation concepts.
- Conduct experiments and evaluations of candidate technologies.
- Initiate preliminary designs.

	FY 2006	FY 2007	FY 2008	FY 2009
Army Hypersonics Advanced Technology	0.000	2.000	0.000	0.000

(U) Establish Hypersonics Advanced Technology initiatives.

	FY 2006	FY 2007	FY 2008	FY 2009
Extreme Light Sources for Defense Applications	0.000	1.440	0.000	0.000

(U) Research extreme light sources.

	FY 2006	FY 2007	FY 2008	FY 2009
Optical Sensor System	0.000	1.000	0.000	0.000

(U) Research optical sensors.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-04

	FY 2006	FY 2007	FY 2008	FY 2009
Research on a molecular approach to HazMat Decontamination	0.000	1.000	0.000	0.000

(U) Research on a molecular approach to HazMat Decontamination.

	FY 2006	FY 2007	FY 2008	FY 2009
RF Counter Sniper	1.000	0.000	0.000	0.000

(U) The RF Counter Sniper program evaluated enabling technologies and system capabilities required to recognize the RF signature of a weapon (rifle, RPG etc.) pointed towards the system in an urban environment, before it is fired. The enabling technologies evaluated were survivability, autonomous operations and command and control.

(U) Program Plans:
- Configured radar and developed algorithms.
- Collected static data, and analyzed radar effectiveness and sensitivity, and developed system CONOPS/trade analysis.
- Collected representative data in a Military Operations in Urban Terrain (MOUT) environment to do final trade analysis and to determine system performance parameters.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)					DATE: February 2007			
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA2 Applied Research				R-1 ITEM NOMENCLATURE: Tactical Technology; PE 0602702E, Project TT-06				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Advanced Tactical Technology TT-06	111.199	111.706	127.550	136.351	145.256	145.256	145.256	145.256

(U) Mission Description:

(U) This project focuses on four 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; (c) enabling technologies for advanced aerospace systems and emerging payload delivery concepts; and (d) new approaches for training and mission rehearsal in the tactical/urban environment. Additionally, this project will develop new tactical systems for enhanced air vehicle survivability, precision optics, electronic warfare, and advanced air breathing weapons.

(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
High Power Fiber Lasers	12.606	6.700	6.242	6.000

(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.

(U) This program will also develop single mode single polarization helical-core fiber lasers. Helical-core fiber lasers overcome the limitations of conventional linear core fibers for bend radius to filter higher order modes at multi-kilowatt output powers. The pitch and offset of helical-core fibers and doping and index profile in the gain region will be optimized for single mode output power.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

(U) Program Plans:
- Demonstrated 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 10 kilowatt single mode, single polarization output power from a helical-core fiber laser.
- Demonstrate capability to coherently combine the output of multi-kilowatt fiber lasers and scale to greater than hundreds of kilowatts output power.

	FY 2006	FY 2007	FY 2008	FY 2009
High Powered FemtoSecond Laser Diodes	5.000	4.000	4.000	2.000

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

	FY 2006	FY 2007	FY 2008	FY 2009
Super High Efficiency Diode Sources (SHEDS)	4.493	4.000	6.000	5.000

(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.

	FY 2006	FY 2007	FY 2008	FY 2009
High Energy Liquid Laser Area Defense System (HELLADS)	21.500	25.000	35.250	35.250

(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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

compared to ground-based systems. The HELLADS program is also funding a novel turbulence control effort, the Aero Adaptive Beam Control program, in order to optimize aft laser operations in flight.

(U) The HELLADS program has completed the design and demonstration of a revolutionary subscale high energy laser that supports the goal of a lightweight and compact high energy laser weapon system. An objective unit cell laser module with integrated power and thermal management is being designed and will be fabricated and demonstrated at an output power of 17 kW. Based on the results of this demonstration, additional laser modules will be fabricated to produce a 150 kW laser that will be demonstrated in a laboratory environment. The 150 kW laser will then be integrated with an existing beam control capability to produce a laser weapon system demonstrator. The capability to shoot down tactical targets such as surface-to-air missiles and rockets will be demonstrated.

(U) The goal of the Aero Adaptive Beam Control (ABC) program is to improve the performance of high energy lasers on tactical aircraft against targets in the aft field of regard. In order to achieve high off-boresight targeting capability, current optical turret designs protrude into the flow. This causes severe aero-optic distortions in the aft field of regard due to turbulence in the wake and the unsteady shock movement over the aperture. These distortions decrease the power flux on target (the measure of lethality for a directed energy system) and limit the directed energy system to targets in the forward field of regard. This program will optimize flow control strategies for pointing angles in the aft field of regard. The program will also explore the ability of the flow control system to be synchronized with the adaptive optics. This effort will initially focus on wind tunnel testing to prove the feasibility of steady and periodic flow control techniques to reduce or regularize the large scale turbulent structures surrounding an optical turret. These tests will culminate in a hardware-in-the-loop demonstration with an adaptive optics system. Following successful wind tunnel demonstrations, a preliminary design of a flight test turret incorporating flow control on the turret and compatible with the HELLADS laser system will be undertaken. Flight test of the selected flow control system will be conducted, simulating an operational system in a representative environment.

(U) Program Plans:

- HELLADS
  - -- Develop and test a 17 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 demonstrator.
  - -- Demonstrate performance of a 150 kW HEL and of a 150 kW laser weapon system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

– Aero Adaptive Beam Control
  -- Conduct design trade studies to develop preferred flow control approach.
  -- Develop wind tunnel test plan and design wind tunnel model.
  -- Conduct preliminary tests of flow control approaches using computational fluid dynamics and small scale wind tunnel tests.
  -- Conduct full scale wind tunnel test to measure aero-optics distortions for turret.
  -- Utilize flow control to reduce aero-optics effects and measure wavefronts to model effects of adaptive optics processing.
  -- Integrate adaptive aero optics system with wind tunnel model to conduct hardware-in-the-loop wind tunnel demonstration.
  -- Design flight test hardware and develop flight test plan.
  -- Build turret incorporating flow control and compatible with HELLADS laser system and flight test measuring beam quality improvement in flight.

	FY 2006	FY 2007	FY 2008	FY 2009
High Performance Algorithm Development	13.371	14.000	14.500	16.000

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

(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.
- 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.
- Develop algorithms for accurate navigation in densely built urban areas based on image matching.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

	FY 2006	FY 2007	FY 2008	FY 2009
Integrated Sensing and Processing	5.000	6.500	8.043	12.000

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

	FY 2006	FY 2007	FY 2008	FY 2009
Training Superiority	20.950	24.271	28.000	35.000

(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, especially those required in the urban environment, that are 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, and 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.
- 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

- 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.
- Exploit technologies developed in massively multi-player online games to create a training environment to detect, recognize, conceptualize, represent and experiment with the problems faced meeting Stability, Security, Transition and Reconstruction (SSTR) objectives, as well as formulate common solutions to these problems within the context of an advanced gaming, simulation, and instrumented environment.
- Develop a biological/physiologically based mathematical foundation for the predictions of the behavior at the individual, small group level and export into training scenarios.
- Leverage the DoD's world class warfare simulations (having validated models and doctrinally correct behaviors) in a persistent Massively Multi-player Game (MMG)-type environment that incorporates a variety of existing technologies including commercial game products, high-performance computers, and agent technologies.

	FY 2006	FY 2007	FY 2008	FY 2009
Air Laser	3.344	3.995	4.400	3.400

(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:
- Performed system/utility analyses.
- Develop and demonstrate a 1 kW output power laser design.
- Develop and demonstrate 20 kW laser design.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

- Develop 100 kW-to-megawatt laser design.
- Develop kilowatt-class red diode stacks.
- Develop high-power mirror coatings for this wavelength.

	FY 2006	FY 2007	FY 2008	FY 2009
Efficient Mid-Wave Infrared Lasers (EMIL)	0.000	2.000	3.000	4.001

(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 wall plug 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:
- Complete 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

	FY 2006	FY 2007	FY 2008	FY 2009
Sonic Projector	0.000	2.500	4.000	3.000

(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 to conceal communications for special operations forces and hostage rescue missions, and to disrupt enemy activities.

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

	FY 2006	FY 2007	FY 2008	FY 2009
Revolution in Fiber Lasers (RIFL)	0.000	0.000	2.500	4.000

(U) The goal of the Revolution in Fiber Lasers (RIFL) program is to develop multi-kilowatt, single-mode, narrow linewidth fiber laser amplifiers using diffraction-limited diode pump arrays to achieve the requisite power and coherence for future multi-kilowatt directed energy architectures. The excellent beam quality of the diffraction-limited diodes allows for a tenfold reduction in cladding diameter. The faster, more efficient coupling from cladding to core will result in a 10x shortening of the required fiber length to avoid nonlinearities and create narrow linewidth beams. Furthermore, the reduction in cladding diameter will provide a 70x increase in the heat removal rate from the core, increasing the thermal fiber laser power scaling limit to 10kW. This program will construct stable 100 W, 10-emitter bars (10W/emitter) and assemble a 15-bar fiber tree capable of producing 1.5 kW of diffraction-limited diode laser pump power per module. These modules will then be used to pump a multi-kilowatt fiber laser amplifier.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

(U) Program Plans:
- Achieve narrow linewidth (<60 MHz), single mode, kilowatt-scale fiber lasers.
- Develop and utilize diffraction-limited laser diode pumps to reduce cladding diameter and length of the fiber laser.

	FY 2006	FY 2007	FY 2008	FY 2009
Coherently Combined High-Power Single-Mode Emitters (COCHISE)	0.000	0.000	3.200	4.200

(U) The objective of the Coherently Combined High-Power Single-Mode Emitters (COCHISE) program is to develop four new, breakthrough technologies that will result in improved diode bar lifetime and beam quality. Ultimately, these technologies will also lead to coherent combination of individual emitters in laser diode bars and arrays. Coherent combination of laser diode arrays would provide high power laser architectures that are up to three times more efficient than existing diode-pumped solid-state laser technology, while improving beam quality and increasing far-field, on-axis intensity.

(U) Program Plans:
- Develop fault mode protection at the laser diode bar level.
- Design new electrical and optical diode bar prescreening technologies.
- Develop 100-watt laser diode bars with > 1-watt, single-mode emitters.
- Design methods for coherently combining high power, single-mode laser diode emitters.

	FY 2006	FY 2007	FY 2008	FY 2009
Laser Enhanced Sighting System (LESS)	0.000	0.000	3.437	6.500

(U) The objective of the Laser Enhanced Sighting System (LESS) program is to design a novel weapon-mounted sighting system that combines optical, night, and thermal sights into a single unit. At present, three different sights are required by the war fighter under various environmental conditions. This results in high costs (over $10K cumulatively) and undue logistics. In addition, presently available night and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

thermal sights are power hungry, which limits their usage, while sighting range and resolution are limited without target illumination and ranging capability. These limitations combine to compromise the warfighter's ability and efficiency to execute missions. The LESS sighting system would weigh approximately one-tenth that of currently available sighting equipment, and greatly extend the duration per charge. The program would provide additional military utility by enabling the warfighter to see targets under all weather and battlefield obscuration conditions, such as illumination under starlight, while enabling ranging to target capability. This program will leverage recent breakthroughs in achieving broad spectral response using MEMS tuning membrane overlaid on an indium-antimony (InSb) or mercury-cadmium-tellurium (HgCdTe) detector/focal plane array.

(U) Program Plans:

- Develop MEMS/InSb or HgCdTe responsivity versus wavelength model as a function MEMS gap to validate if the responsivity of the combined system could be improved by a factor of 10x.
- Develop MEMS tunable membrane on InSb or HgCdTe substrates and measure performance with wavelength at known voltages and temperature.
- Design and build electronics board sufficient to record images at various wavelengths with and without MEMS membrane.

	FY 2006	FY 2007	FY 2008	FY 2009
Architecture for Diode High Energy Laser Systems	8.237	8.000	4.978	0.000

(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 decrease 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

(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.

	FY 2006	FY 2007	FY 2008	FY 2009
Laser Star	4.900	2.000	0.000	0.000

(U) The Laser Star program is investigating 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 is exploring approaches to overcome these shortfalls including advanced multi-conjugate adaptive optics as well as nonlinear techniques.

(U) Program Plans:
- Completed concept design.
- Developed experiment design and procured long lead items.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

– Conduct experiment and analyze results for integration with atmospheric compensation programs.

	FY 2006	FY 2007	FY 2008	FY 2009
Coherent Communications, Imaging and Targeting	6.200	5.000	0.000	0.000

(U) The Coherent Communications, Imaging and Targeting (CCIT) program is developing new capabilities for secure communication up-links, and aberration free 3-dimensional imaging and targeting at very long ranges. Innovative design concepts for MEMs based Spatial Light Modulators (SLMs), and system integration of photonics and high-speed electronics are also being explored.

(U) Program Plans:
– Complete 64 x 64 device with individually "wired" test pixels.

	FY 2006	FY 2007	FY 2008	FY 2009
Rapid Checkpoint Screening	5.466	3.740	0.000	0.000

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-06

	FY 2006	FY 2007	FY 2008	FY 2009
Language and Speech Exploitation of Resources Advanced Concept Technology Demo	0.132	0.000	0.000	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 transitioned 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.
- Tested and evaluated technology in operational context; LASER ACTD effort complete.

(U) Other Program Funding Summary Cost:

- Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07					
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Aeronautics Technology TT-07	59.179	69.927	76.326	98.576	105.752	105.752	132.174	145.752

(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 2006	FY 2007	FY 2008	FY 2009
Micro Adaptive Flow Control (MAFC)	4.106	4.619	0.000	0.000

(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:

- Completed sled design and fabrication for High Frequency Excitation for Supersonic Weapons Release (HIFEX) phase III test.
- Completed HIFEX system design and fabrication for HIFEX phase III test.
- Designed and integrated SCORPION full-scale control system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

- Completed 1- Mach 2.0 HIFEX system sled test.
- Complete SCORPION system design and fabrication for SCORPION phase III test.
- Configure and execute Phase III full-scale technology demonstrations.

	FY 2006	FY 2007	FY 2008	FY 2009
Miniature Propulsion Concepts	7.340	5.334	6.706	7.500

(U) Small Unmanned Air Vehicle (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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Peregrine Counter UAV	1.219	5.146	6.840	3.000

(U) The Peregrine Counter Unmanned Air Vehicle (UAV) program will develop a low-cost capability to counter small UAV threats. Small UAVs with GPS guidance systems have reached such a low cost level that expendable UAVs can be easily obtained from components available to the civilian aircraft and hobby market. Current air defense assets are unable to provide a cost effective response to this threat. 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 loiter and surveillance and a very high dash speed for intercept and kill. The program will also identify operating scenarios and system requirements for both domestic situations and regions of conflict, validate critical technologies, and demonstrate a suitable system design and concept of operations.

(U) Program Plans:
- Defined system requirements.
- Develop concept design.
- Demonstrate feasibility of threat detection and airspace integration.
- Demonstrate aircraft performance and kill capability.

	FY 2006	FY 2007	FY 2008	FY 2009
High Speed / Hypersonic Reusable Demonstration	30.000	20.700	0.000	0.000

(U) This program is a joint DARPA/Air Force initiative that is designing, developing, and demonstrating combined cycle engine components for a reusable hypersonic cruiser in conjunction with the Falcon program (PE 0603287E, Project SPC-01). Ultimately, the studies and developments under this program 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).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

(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+.

(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
  - -- Conducted Critical Design Reviews of two engine concepts.
  - -- 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
  - -- Developed the flight vehicle design.
  - -- Conducted freejet engine testing.
  - -- Fabricate flight demo vehicle.
  - -- Conduct flight testing.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Helicopter Quieting	5.020	8.872	10.900	10.800

(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 rotorcraft design tools that will enable the creation of novel rotor systems that can dramatically reduce the acoustic signature of a helicopter without sacrificing flight performance.

(U) Current rotor development is very costly, involving a time-consuming iterative, trial and error cycle of analysis and model wind tunnel tests, or occasionally, a faster but much riskier analysis path directly to full-scale wind tunnel/flight test. This program will leverage recent advances in computational fluid dynamics to develop physics-based predictive design tools that will enable helicopter rotor designers to explore the revolutionary potential of emerging new rotor noise-reducing technologies with a reduction in the cost and cycle time associated with iterative analysis and test. The program will investigate multiple advanced, low-noise rotor concepts for application to fielded military rotorcraft for a significant reduction in low-frequency in-plane signatures. The most promising concepts will be taken to test, culminating in full scale flight experiment of advanced rotors to confirm acoustic signature reduction and evaluate survivability improvement in an operational environment.

(U) Program Plans:

- Develop and validate high-fidelity, physics-based rotor acoustic predictive tools.
- Identify acoustic design criteria for new rotor system designs based on operational scenarios.
- Develop advanced rotor system designs that incorporate reductions in low-frequency, in-plane signatures for increased survivability without significant impact to flight performance.
- Demonstrate acoustic signature reduction and improved effectiveness in system test and experiment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Nano-Flapping Air Vehicles	5.924	6.956	9.250	9.524

(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, small payloads, and the ability to perch like a bird. 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 the aerodynamic wing-mechanism design.
- Integrate wing design with air vehicle.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Flare Aero Structures	2.000	3.631	0.000	0.000

(U) The Flare Aero Structures program explored and developed a new concept for the take off and landing of a fixed wing aircraft. The landing field requirement for a fixed wing aircraft limits use in both confined (e.g. urban) and remote unprepared areas. This program sought to explore 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 was to develop the aero structures, control effectors and control logic that would allow for a practical application of this phenomenon to a fixed wing aircraft to enable landing in a very short distance.

(U) Program Plans:
- Developed aerodynamic models and control logic.
- Conduct flight experiments with scaled aircraft.

	FY 2006	FY 2007	FY 2008	FY 2009
Battlefield Helicopter Emulator (BHE) (formerly MACAW)	3.570	6.469	8.750	8.400

(U) The goal of the Battlefield Helicopter Emulator (BHE), formerly 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. BHE 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 BHE 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:
- Characterize the acoustic and thermal infrared (IR) signatures of common helicopters.
- Develop concepts to emulate common helicopter acoustic and thermal IR signatures.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

- Select and integrate sensors and UAV platform.
- Conduct field tests to determine system capability and effectiveness against potential threats.

	FY 2006	FY 2007	FY 2008	FY 2009
Distributed Embedded Propulsion	0.000	4.000	7.000	8.000

(U) The Distributed Embedded Propulsion project will explore fully integrated engine/wing designs to take maximum advantage of a fully coupled engine/wing system. This concept will utilize multiple small engines to provide the thrust for the aircraft, and to allow the engines to be more readily integrated with the aircraft structure and the aerodynamics of the wing. It is expected that distribution of propulsive flow over the wing surface will 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 take-off and landing distance. Military transition targets would be short take-off and landing airlift and transport vehicles, benefiting from improvements possible in take-off 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Laminar Flow Flight Demonstration	0.000	3.200	5.500	9.000

(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 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 2006	FY 2007	FY 2008	FY 2009
Long Endurance Autonomous Powered Powerfoil (LEAPP)	0.000	1.000	3.250	6.500

(U) The goal of the Long Endurance Autonomous Powered Powerfoil (LEAPP) program is to design, develop and integrate the enabling technologies and system capabilities required to demonstrate an extremely short take-off and landing (ESTOL) vehicle with large payload and long endurance characteristics. The enabling technologies are precision guidance, autonomous operations, parafoil aerodynamic performance, and parafoil integration with sensors/antennas. A LEAPP system will provide 48-hours of continuous organic air-support to small ground units or small marine vessels with a 200lb surveillance and communication package. In addition, the LEAPP will have flexibility to be deployed rapidly and will be affordable based on modular system design and construction.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

(U) Program Plans:
- Develop LEAPP prototype and demonstrate flight performance.
- Conduct system level tests for specific missions and CONOPS.
- Demonstrate operational effectiveness for a class of missions.

	FY 2006	FY 2007	FY 2008	FY 2009
Disc-Rotor Compound Helicopter	0.000	0.000	3.000	6.000

(U) The goal of the Disc-Rotor Compound Helicopter program is to design and demonstrate the enabling technologies required to develop a new type of compound helicopter capable of high-efficiency hover, high speed flight, and seamless transition between these flight states. The aircraft will be equipped with a rotating circular wing having blades that can be extended from the disc edge, enabling the aircraft to takeoff and land like a helicopter. Transition from helicopter flight to airplane flight would be achieved by gradually retracting and stowing the blades as the circular wing assumes the task of lifting. An aircraft capable of long range high speed (300-400 kts) and VTOL/hover will provide mobility and responsiveness for troop and cargo insertion, satisfy an ongoing military interest for higher speed VTOL and hover capable vehicles, be survivable and bridge the gap in helicopter escort and insertion missions. The enabling technologies are disc-rotor configuration, circulation control, seamless reversible transition between hover and wing borne flight, and loading/center-of-pressure control. Specific objectives of the Disc-Rotor Compound Helicopter program include: characterization of the flowfield environment created by a disc-rotor, demonstration of disc-rotor configuration, and design and demonstration of prototype vehicle transition dynamics and operational utility.

(U) Program Plans:
- Develop a conceptual design and technical approach.
- Identify, develop, and demonstrate the critical enabling technologies required to meet the performance goals.
- Design an integrated scaled concept demonstrator vehicle that proves the viability of a disc-rotor concept.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Integrated Compact Engine Flow Path	0.000	0.000	3.500	7.000

(U) The goal of the Integrated Compact Engine Flow Path program is to develop a structurally integrated, load bearing, and thrust vectoring nozzle. Integration of compact inlets and nozzles that are lightweight and survivable continue to be a challenge. Traditional nozzles are cantilevered off the engine face and the airframe, with an overlap region to account for thermal growth. This approach to nozzle integration results in heavy, high maintenance nozzles and is structurally inefficient. It also poses a significant engine integration challenge and can drive vehicle sizing. A fully integrated nozzle, designed to take airframe loads through the nozzle, and built of a high temperature ceramic, would address the weight and structural integration problems directly. This approach would also be compatible with fluidic thrust vectoring and would result in a more compact, lighter, and more durable nozzle. Indications are that installed weight reductions of over 50% compared to existing state of the art thrust vectoring nozzles are feasible. This program will design, develop, and demonstrate a full scale, fluidic thrust vectoring nozzle in a direct connect engine test.

(U) Program Plans:
- Perform design trade studies to develop a preferred nozzle design as well as a development and demonstration plan.
- Perform materials and small-component testing.
- Develop nozzle preliminary design.
- Perform detailed design, fabrication, and direct-connect engine test.

	FY 2006	FY 2007	FY 2008	FY 2009
Dropout	0.000	0.000	2.000	3.500

(U) The Dropout (Dead Reckoning for UAV Operations in Urban Terrain) program will develop technologies which provide robust GPS aided navigation to UAVs in environments that are currently problematic. Dropout will address the loss of UAVs that result from navigation failure when GPS signals are interrupted. The solution will include three technical approaches which will be evaluated for operational feasibility: an

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

integrated GPS/INS (Internal Navigation System) which uses accelerometers and gyroscopes tightly coupled with GPS to estimate position when GPS signals are absent; independent sensors such as magnetometers and gravitometers to provide independent information on altitude and orientation; and imagery based navigation systems which use the UAV's own cameras as navigation aides. These solutions will be particularly valuable in urban terrain and will be applicable to future UAVs.

(U) Program Plans:
- Conduct requirements and interface study.
- Select teams for navigation system development.
- Develop systems and test on UAVs.
- Assist in transition to Services.

	FY 2006	FY 2007	FY 2008	FY 2009
Accelerator	0.000	0.000	3.000	5.300

(U) Accelerator is a technology program to develop accelerator propulsion systems suitable for a variety of high-speed missile and/or vehicle concepts that require substantial off-design thrust from initiation through SCRAMJET-ignition in the flight trajectory. Accelerator will solicit and mature innovations that allow off-the-shelf military turbojet engines to meet the demands of the hypersonic ignition trajectories. Integration technologies unique to high-speed vehicles will also be addressed including variable inlets and nozzle geometries.

(U) Program Plans:
- Evaluate engine performance enhancers such as mass injection and pre-compression cooling (MIPCC).
- Conceptual design to establish required engine performance.
- Closed loop accelerator technology testing in ground facility to simulate design trajectory.
- Free-jet testing of accelerator system including engine and exhaust nozzles as system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

	FY 2006	FY 2007	FY 2008	FY 2009
Active Rotor	0.000	0.000	3.380	6.852

(U) The goal of the Active Rotor program is to develop and demonstrate enabling technologies that greatly enhance rotor control and performance to enable a 25-50% improvement in endurance, range, and payload of existing helicopters. Enabling technologies include a dynamically controlled rotor, lightweight high-bandwidth compliant actuators, and integrated vehicle flight control technologies. Over the past several decades, improvements in helicopter rotor performance have not kept pace with the increasing demands of the warfighter. This is apparent today in the high altitude environment of Afghanistan, where troop and materiel transport missions that are normally performed by the UH-60 Black Hawk are being performed by the much larger CH-47 Chinook due to the loss of performance in high/hot conditions. The Active Rotor program will mature the technologies to enable military aircraft such as the Black Hawk to operate effectively in this environment. The Active Rotor program will focus on upgrade of the current UH-60/SH-60/MH-60 Black Hawk/Sea Hawk rotor blades and will demonstrate technologies with broad applicability to military and commercial helicopters.

(U) Program Plans:
- Conduct component technology demonstrations and initiate preliminary design of the Active Rotor System.
- Perform full scale wind tunnel test of the Active Rotor System.
- Conduct flight test of the Active Rotor System.

	FY 2006	FY 2007	FY 2008	FY 2009
Lightweight High Efficiency Aircraft Power Generation	0.000	0.000	3.250	7.200

(U) The goal of the Lightweight High Efficiency Aircraft Power Generation program is to develop a lightweight, fuel-efficient system to deliver up to 2 megawatts (MWs) of electrical power to support the integration of high energy laser weapons on airborne platforms. Conventional power generating systems of this scale are large and heavy, respond too slowly to power demands from the laser system, are not fuel efficient, and impose a significant performance penalty on the host aircraft. The program will develop and demonstrate at least one novel power generation

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-07

approach that is capable of providing full power (2 MW at 40,000ft/0.8Mach) within 0.1-2.0 seconds and that can operate in a fuel-efficient standby mode. The power generation system will be tailored for integration on existing bomber and transport aircraft with minimal integration penalties and will support both high energy laser and high power microwave weapons.

(U) Program Plans:
- Conduct system trade studies and preliminary design.
- Demonstrate key technologies.
- Fabricate and characterize demonstrator.
- Conduct ground-based performance demonstrations with a high energy laser.

(U) Other Program Funding Summary Cost:

- Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13					
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Network Centric Enabling Technology TT-13	60.225	68.067	72.699	81.966	92.458	92.258	92.258	92.258

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
Networked Embedded Systems Technology (NEST)	4.000	6.000	4.000	3.000

(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.

(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:

- 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

- 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 2006	FY 2007	FY 2008	FY 2009
Combat Zones That See (CZTS)	7.436	5.000	6.000	8.000

(U) The Combat Zones That See (CZTS) program improves the situational awareness, effectiveness, and safety of U.S. military forces in foreign urban environments (e.g., Mozul). CZTS provides close-in sensing and extended reconnaissance capabilities using a network of video sensors. The system tracks vehicles over urban areas using sparse arrays of video cameras, automatically detecting vehicles that may be involved in hostile activities based on the observed tracks. This network produces an extreme amount of raw data, precluding human analysis, so advanced video understanding algorithms embedded in commercial-off-the-shelf hardware systems monitor the video feeds automatically. As processing requirements become well-understood, novel image-processing chips will be integrated and interleaved with focal plane arrays within a conventional camera architecture, and a fully-compatible communications link developed to support a video-based system for perimeter defense. 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:

- Developed, installed overseas, and evaluated a force protection prototype that employs approximately 30 cameras.
- Demonstrated sustained tracking of individual vehicles using sensors whose fields-of-view do not overlap.
- 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.
- Simulate the processing of pixel information in the image plane of video camera, to distinguish fundamental features of humans/animals/machines, such as the cooperative movement of aggregate pixel features.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

- Demonstrate semiconductor circuitry for integration within the image plane of the camera, to process pixel information in an energy-efficient way for identification for perimeter intrusion.
- Demonstrate the completed video sensor system, for actual determination of human/animal/machine penetration of a perimeter defensive system.
- Develop, install, and evaluate a rapid deployment prototype using approximately 100 rapidly deployed cameras.

	FY 2006	FY 2007	FY 2008	FY 2009
Automated Battle Management	13.723	17.400	20.418	18.328

(U) The pace of battle will continue to increase as more-capable platforms and higher-bandwidth 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) program develops autonomous control methods to cause a distributed set of unmanned undersea vehicles to self-organize and distribute tasks through judicious transactions conveyed over a shared communications network. CNAV illustrates these capabilities through development of a capability for submerged target detection, localization, and tracking in restrictive littoral waters. CNAV provides this capability by creating a field of dozens or hundreds of vehicles, networked through acoustic wireless communications. The vehicles work collaboratively and autonomously to detect, classify, localize and track target submarines transiting the field. The field self-organizes to adapt to changes in target locations, environmental conditions, and operational factors. A reach-back capability allows reporting of field health and enables high-level orders 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 detection in littoral waters.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

- The Organic Sensor Exploitation Network (OSEN) program goal is to provide truly persistent, all-weather, day/night surveillance of a large ground area from the air using multiple radars providing imagery and target detection data at a high revisit rate. 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; (5) develop effective low-cost, light-weight radars and (6) transition targets to other platforms as different targets move through sensor fields-of-view. OSEN system-level studies evaluate the relative value of different sensor mixes against low-flying aircraft, ground vehicles, dismounted infantry, and irregular forces. The program accommodates variable communications connectivity, moving processing loads from one vehicle to another as network topology changes due to platform motion.

(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.

– Organic Sensor Exploitation Networks (OSEN)
  -- Define representative sensor mixes and operational scenarios.
  -- Perform analytical trade studies to generate representative sensor network components and tactics.
  -- Develop a network node architecture adaptable to the devices present at that node.
  -- Design and develop a radar system, which demonstrates the component hardware and signal processing technologies needed to realize a small-unmanned aerial vehicle (UAV)-based radar constellation.
  -- Develop signal processing and exploitation algorithms for multi-platform radar imagery and moving target detections.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

-- Prototype candidate algorithms for each function (search, detect, track, identify, correlate, hand off) and for constellation resource management, scheduling and control 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 2006	FY 2007	FY 2008	FY 2009
Urban Warfare Robotic Surveillance (URS)	10.600	6.920	0.000	0.000

(U) The Urban Warfare Robotic Surveillance System (URS) program develops 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 (normal and 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 are being 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. The URS program also supports the DARPA Urban Challenge.

(U) Program Plans:
- Developed alternative sensor models and algorithms (signal processing, object detection, object recognition, mapping, correlation, tracking, and route generation and communications management).
- Compared alternatives in the synthetic testbed. Select combinations that offer the most robust and effective performance.
- Construct a software testbed where candidate system components can be exercised in a synthetic urban battlespace.
- Build a hardware testbed incorporating selected component sensors and algorithms.
- Exercise test platforms in a series of increasingly difficult mission/environment combinations.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

- Improve sensors or algorithms that limit performance.
- Fund technology development contracts and program planning support for the DARPA Urban Challenge.

	FY 2006	FY 2007	FY 2008	FY 2009
Home Field	7.790	13.700	15.000	14.000

(U) The Home Field program develops networked video and Laser Detection and Ranging (LADAR) processing technology to rapidly and reliably update a 3D model of an urban area. It provides 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) Home Field also provides high resolution 3D data that can drive novel 3D display concept. A new element of Home Field is the Urban Photonic Sandtable Display (UPSD) project, which develops and demonstrates interactive holographic display of complex volumetric 3D data to replace current 3D visualization technologies that are either static or have limited effective field-of-view. The UPSD project is developing a 3D display system that is scalable, operates at full video rate, includes color, and supports a wide viewing angle. The result will be the world's first full-motion 3D imaging technology system.

(U) Program Plans:

- Conducted a validation demonstration on a 1-foot by 1-foot active hogel design for the UPSD.
- Validated a monochrome active hogel-based proof-of-concept display by transforming computer data into optical data, making sophisticated integration possible to optimize image quality.
- Demonstrate a 3D-model method that used 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

- Demonstrate an effective man-machine interface to edit/update the extracted features.
- Demonstrate a model update approach that keeps the urban cartographic representation current.
- Fully develop an active hogel module to provide necessary optical and electrical performance.
- Build and customize the active hogel modules into 2-foot by 2-foot and 3-foot by 3-foot systems.
- Operate the final system at full video rate, color display, and with the possibility of tiling to larger display scales (e.g., 6-feet by 6-feet).

	FY 2006	FY 2007	FY 2008	FY 2009
Adaptive Reflective Middleware Systems	6.120	7.860	8.000	8.000

(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 in the DD(X) Future Surface Combatant Family of Ships; however, the technology is applicable to other network-centric DoD systems. This environment executes all tasks and mission applications optimized at the platform level, rather than the subsystem level. Autonomous computing 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 capabilities of the underlying network and end systems.

(U) Program Plans:

- Defined and prototyped algorithms, adaptive protocols, patterns, and technologies.
- Developed technologies to enable the use of the Java programming language in time-critical applications.
- Enforced security policies to enhance and support secure resource allocation, scheduling, and control; ensured stability and dependability across the intra-ship network.
- Developed 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 middleware and applications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

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

	FY 2006	FY 2007	FY 2008	FY 2009
Integrated Crisis Early Warning System (ICEWS, formerly PCAS)	3.156	5.747	6.000	8.000

(U) The Integrated Crisis Early Warning System (ICEWS, formerly PCAS, Pre-Conflict Anticipation and Shaping) program will develop and integrate a set of data analysis tools into a unified information system to support Theater Security Cooperation. The ICEWS system will monitor, assess and forecast leading indicators of events that make countries vulnerable to a variety of national and international crises. ICEWS 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 tools allow combatant commanders and their staff to understand and anticipate conditions that precipitate instability and conflict - while there is still time to influence them. ICEWS also helps anticipate unintended consequences of actions taken to influence or remediate situations - consequences that may be delayed by months or years.

(U) Program Plans:

- Augment social science models with emerging computational social science model and theories.
- Obtain and organize a large corpus of data describing a representative set of countries and regions in Pacific Command (PACOM) that are expected to range from stable to highly unstable social dynamics.
- Build tools to automatically translate the data corpus into a form usable by quantitative and computational social science models.
- Develop new crisis monitoring and forecasting models across multiple timescales and levels of analysis.
- Integrate in a real-time analytical system.
- Conduct regular experiments to assess predictions in an operational environment.
- Develop tools that can be transitioned to the staff at Combatant Commands (PACOM HQ).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

	FY 2006	FY 2007	FY 2008	FY 2009
Diagnostic Network Economies	3.000	4.000	3.000	3.000

(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:
- Leverage and extend the available techniques for information fusion across multiple data sources, and anomaly detection.
- Explore new approaches to reasoning in the presence of partial and unreliable information.
- Research new approaches to discover and maintain dependencies within network centric warfare systems.
- Research networking architectures that sidestep diagnostic complexity by deliberately inducing simpler diagnostic problems.

	FY 2006	FY 2007	FY 2008	FY 2009
Visualizing the Info Ops Common Operating Picture (VIOCOP)	0.000	0.000	3.125	5.000

(U) The goal of the Visualizing the Info Ops Common Operating Picture (VIOCOP) program is to provide a commander with a standardized and logical way of depicting the impact of Information Operations on conventional missions. Great strides have been made in digitizing the battlefield and developing standardized sets of representations for the commander to visualize the physical battlefield. However, the area of information operations concerns operations that do not map cleanly to "kinetic" operations and geography. An informationally rich and succinct visual representation of non-geographic, non-kinetic information operations is needed to appropriately assess progress during an information

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

operations campaign as well as to understand interactions with ongoing conventional operations. Information operations require the commander to understand issues and impacts that may be well outside his defined area of responsibility but have significant consequences to the success (or failure) of a mission.

(U) Program Plans:
- Research a meaningful symbology and depiction of information operations concepts for the broadest definition of information operations (to include technical, social, geographic, cultural, tactical, cyberdefense, etc.).
- Prototype a digital information operations picture using this symbology that is integrated with the Commander's common operation picture.
- Research human-computer interfaces to visualize and manipulate information operations data.
- Research a modeling and simulation capability for information operations.
- Research mechanisms to integrate the tactical picture with the information operations information.

	FY 2006	FY 2007	FY 2008	FY 2009
Very High Speed Torpedo Defense	0.000	0.000	4.156	8.638

(U) The Very High Speed Torpedo Defense program will develope concepts for U.S. ship defense systems to defeat very high speed (250 knot) rocket-powered super-cavitating torpedoes currently under development by other nations. Queued by a ship's sonar system, the torpedo can be identified and localized using a large search volume laser-radar tracking system that can be used to compute a firing solution. The torpedo will then be engaged using specially designed high speed projectiles (also super-cavitating) fired from the ship to neutralize the incoming threat.

(U) Program Plans:
- Validate preliminary sensor and weapon concepts.
- Design and test final system components, including the laser sensor, the cueing and targeting mechanism, and the projectile weapons.
- Demonstrate and test the entire system using test rigs and lake facilities.
- Conduct a final series of ocean tests in a variety of sea state conditions.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

	FY 2006	FY 2007	FY 2008	FY 2009
Kick Stand	0.000	0.000	3.000	6.000

(U) This effort will use directed ultrasound technology to enable the capability to significantly reduce sound emissions from large scale tactical military hardware. Theory predicts that nonlinear effects of high-power acoustic radiation on the atmosphere can cause acoustic energy to dissipate rather than radiate. This theory has been confirmed in some limited experiments; this program will apply it to reducing acoustic emissions of U.S. equipment. Reduction in noise levels by at least 30dB would enable U.S. forces to effectively operate considerably closer to enemy forces without being detected aurally.

(U) Program Plans:
- Validate the theoretical models in laboratory settings.
- Estimate power levels and secondary effects required to sustain an ultrasonic curtain around a vehicle.
- Demonstrate absorption of transverse acoustic energy through a vertically projected ultrasonic field.
- Design a complete system for shielding a truck-sized vehicle.
- Demonstrate shielding for a stationary vehicle.
- Conclude with a field demonstration of a vehicle operating over a military test range.

	FY 2006	FY 2007	FY 2008	FY 2009
R31 Systems: Next Generation of Intelligent Communications	1.700	1.440	0.000	0.000

- Selected and continue to fund initiatives for the next generation of intelligent communications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2007
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, Project TT-13

	FY 2006	FY 2007	FY 2008	FY 2009
Enhancement of Communications and Telemetry Support	1.700	0.000	0.000	0.000

(U) Selected and funded initiatives for the enhancement of communications and telemetry support.

	FY 2006	FY 2007	FY 2008	FY 2009
MESH-Enabled Architecture	1.000	0.000	0.000	0.000

(U) Selected and funded initiatives for MESH-enabled architecture.

(U) Other Program Funding Summary Cost:

- Not Applicable.