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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E				
COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	300.721	335.967	371.481	355.591	322.212	324.712	326.393
Naval Warfare Technology TT-03	35.728	36.676	38.893	40.125	40.109	40.109	40.109
Advanced Land Systems Technology TT-04	49.853	60.286	82.421	83.580	79.752	80.147	79.354
Advanced Tactical Technology TT-06	103.715	113.550	114.421	84.028	59.820	59.820	60.314
Aeronautics Technology TT-07	58.505	52.756	58.158	64.856	67.486	68.105	70.086
Network Centric Enabling Technology TT-13	52.920	72.699	77.588	83.002	75.045	76.531	76.530

(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. Technologies under development will increase survivability and operational effectiveness of small and medium surface vessels in rough seas and demonstrate advanced technologies for hypersonic flight. New areas to be investigated include ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations and predictive tools for small craft hydrodynamic design.

(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.

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(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.

(U) **Program Change Summary:** *(In Millions)*	**FY 2007**	**FY 2008**	**FY 2009**
Previous President's Budget	359.936	374.717	436.842
Current Budget	300.721	335.967	371.481
Total Adjustment	-59.215	-38.750	-65.361
Congressional program reductions	-35.000	-49.550	
Congressional increases	0.000	10.800	

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Reprogrammings	-15.000
SBIR/STTR transfer	-9.215

(U) Change Summary Explanation:

FY 2007	Decrease reflects a departmental reprogramming (PA 07-18) and the SBIR/STTR transfer.
FY 2008	Decrease reflects reductions for Section 8097 Contractor Efficiencies and Section 8104 Economic Assumptions, offset by congressional adds CEROS and Optinet Sensor System.
FY 2009	Decreases reflect programs ending or transitioning in Advanced Land Systems Technology (NetEx, Sticky Flares), Advanced Tactical Technology (High Power Fiber Lasers, Air Laser), Aeronautics Technology (Hypersonics Demonstration), and rephasing of Network Centric programs.

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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 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Naval Warfare Technology TT-03	35.728	36.676	38.893	40.125	40.109	40.109	40.109

(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, ship stability, hypersonic missiles, logistically friendly distributed lighting systems, ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, and high bandwidth communications.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Friction Drag Reduction	5.125	3.700	0.000

(U) The Friction Drag Reduction program has developed and demonstrated physics-based, engineering design tools that will predict additive-based friction drag reduction on Navy surface ships. To date, the program has developed the capability to predict how turbulent flows are modified by the presence of polymers and air injection and has identified hull designs on which air layer drag reduction would be cost-effective. Air injection effects were confirmed with small-scale physical experiments and tests in a large-scale facility at ship-relevant scales. Large scale experiments have been conducted on a thirteen 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 injections were tested with simulated surface roughness to assess the effects caused by biofouling on hulls.

(U) Program Plans:

FY 2007 Accomplishments:

– Verified effects of air and polymer injection on flat plate tests at representative ship scales and speeds.

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– Experimentally determined how additive-based friction drag reduction is influenced by the presence of significant surface roughness.

FY 2008 Plans:

– Evaluate approaches and hull designs suitable for realistic at-sea tests to evaluate the effect of sea states, maneuvering conditions, biofouling, ship curvature and pressure gradients on injection and additive based drag reduction approaches.

	FY 2007	FY 2008	FY 2009
Center of Excellence for Research in Ocean Sciences (CEROS)	5.600	10.000	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. CEROS has been funded through Congressional earmarks and funds targeted for CEROS were not included in the President's Budget request.

(U) Program Plans:

FY 2007 Accomplishments:

– Completed projects started in FY 2006.
– Selected projects for FY 2007 funding.
– Contracted for selected projects and monitored progress of ocean related technologies of high interest to the DoD.

FY 2008 Plans:

– Complete projects started in FY 2007.
– Select projects for FY 2008 funding.
– Contract for selected projects and monitor progress of ocean related technologies of high interest to the DoD.

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	FY 2007	FY 2008	FY 2009
Acoustic Arrays for Torpedo Defense	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:

FY 2007 Accomplishments:

- Designed, developed, and tested a two-element transducer module.
- Completed design improvements on second generation transducer module.
- Successfully tested second generation transducer module.

FY 2008 Plans:

- Develop scaled prototype 8x2-element transducer array.
- Sucessfully beamform pressure pulses.
- Validate non-linear pulse propogation model for extended ranges.
- Conduct demonstration of pulse focusing and beam-steering with prototype 8x2-element transducer array.

	FY 2007	FY 2008	FY 2009
Unique Propulsion Techniques	2.628	1.000	0.000

(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

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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:
FY 2007 Accomplishments:
- Accurately modeled the physics of ribbon fin propulsion and created predictive design tools.
- Designed and demonstrated a ribbon fin propulsion system on an appropriately scaled surrogate platform.

FY 2008 Plans:
- Complete final testing and documentation of technologies.

	FY 2007	FY 2008	FY 2009
Riverine Crawler Underwater Vehicle	2.013	2.500	0.000

(U) The Riverine Crawler Underwater Vehicle program will develop unmanned underwater vehicle concepts that can transit underwater in riverine and shallow water coastal environments and carry out surveillance/reconnaissance and deployment tasks in denied, sensitive or contested areas. The program will study means of operating an unmanned submerged craft in riverine shallow water areas (nominally at operational environment depths of <40ft) including rivers, estuaries and harbors involving challenging surface and sub-surface conditions such as obstructions, turbidity, wave action and currents. Novel means of navigation, propulsion and sensing will be required to operate autonomously in such environments. 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:
FY 2007 Accomplishments:
- Performed concept of operations studies.

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FY 2008 Plans:
- Identify enabling technologies that support an autonomous underwater vehicle concept that is capable of operating in shallow water (<25 feet) including riverine, coastal and harbor environments.
- Develop concept designs to enable a new sub-surface capability for riverine and other shallow water operations.

	FY 2007	FY 2008	FY 2009
Wideview	1.158	3.500	0.000

(U) The Wideview 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:
FY 2007 Accomplishments:
- Investigated feasibility of adapting technology.

FY 2008 Plans:
- Complete feasibility study and document lessons learned.

	FY 2007	FY 2008	FY 2009
Super-Fast Submerged Transport	8.000	12.100	25.893

(U) The Super-Fast Submerged Transport program (Underwater Express) 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

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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.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed models and simulations for cavitator performance, including cavity generation and stability.
- Conducted subscale experiments and developed understanding of cavity geometry over a range of operating conditions.
- Developed and experimentally verified methods for generating stable cavities over a range of operating conditions.
- Developed initial design trade critical issues including sizing estimates for a scale and full-scale vehicle.
- Modeled and analyzed design vehicle system stability and vehicle control issues.

FY 2008 Plans:

- Conduct modeling, simulations, and experiments to develop an understanding of cavity and vehicle interactions and the effect of these interactions on vehicle design, control and stability.
- Continue development of vehicle design including propulsion system design and integration, and design, fabrication and testing of a scaled prototype vehicle.
- Commence design, fabrication, and testing of a scaled prototype vehicle.
- Model, simulate, and experimentally measure vehicle maneuvering and body forces in a controlled facility.
- Develop vehicle and cavity scaling relationships.

FY 2009 Plans:

- Design, fabricate and test a scaled prototype vehicle.
- Analyze prototype performance for speed, power and stability.
- Develop vehicle and cavity scaling relationships.

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

(U) Images seen through an air-water interface are distorted by multiple refractions from the water surface. This program will develop high-resolution imaging and image exploitation technology to provide new capabilities for detection and discrimination of objects such as surface crafts and underwater objects, which could significantly improve near-surface operations and safety.

(U) Program Plans:
FY 2008 Plans:
- Conduct experiments and scale testing of imaging algorithms.
- Conduct modeling to characterize resolution, image quality, and performance in various water qualities and optical conditions.

	FY 2007	FY 2008	FY 2009
Extremely Long Endurance Unmanned Surface Vehicle (ELEUSV)	0.000	0.000	4.000

(U) The Extremely Long Endurance Unmanned Surface Vehicle (ELEUSV) program will develop technologies that allow a robotic naval vessel to operate for years with minimal human interaction beyond tasking. This will enable a significant expansion of naval presence and will provide potential advantages in counter mine and anti-submarine warfare, emergency response and rescue operations, and intelligence gathering. Technologies to be explored include energy harvesting from the environment in order to power vessels for multi-year periods, command and control systems to enable global operations of remotely supervised systems, and de-fouling and other self-maintenance capabilities. The ELEUSV program will also investigate unique payload systems that will benefit from the extended periods of uninterrupted operations.

(U) Program Plans:
FY 2009 Plans:
- Conduct analysis of ELEUSV deployment time limiting factors.
- Identify core technologies required to enable multi-year operational deployments.

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– Develop operational system concept designs and technology integration plan.

	FY 2007	FY 2008	FY 2009
Broad Ocean Demining	0.000	0.000	4.000

(U) The Broad Ocean Demining program will develop and demonstrate system capabilities to counter maritime Improvised Explosive Devices (IEDs) and protect global military and economic maritime interests from disruption. By enabling the rapid detection of mines, mining operations, and other asymmetric IEDs and developing methods of rapidly clearing those threats from critical areas, the program will increase assured operations of military and non-military ocean traffic. Additionally, the program will explore innovative distributed systems that can escort ships and allow them to detect, avoid, and if necessary, neutralize these threats while underway. Technical elements include surveillance networks that can be rapidly emplaced and affordably monitored, improved detection and neutralization techniques, and robotic systems that can carry out the search and neutralization missions with minimal support from military ships.

(U) Program Plans:
FY 2009 Plans:
– Define prioritized threat vectors based on potential to disrupt military and commercial shipping.
– Identify core technologies to enable affordable and effective defeat of these threats.
– Develop broad ocean demining architectural concept and system integration plan.

	FY 2007	FY 2008	FY 2009
High Bandwidth Maritime Communications	0.000	0.000	5.000

(U) The High Bandwidth Maritime Communications program will develop and exploit nonlinear optical processes to efficiently translate an arbitrary optical waveform from one wavelength band to another, allowing use of commercial laser components signal-processing techniques, and advanced photonic technology in underwater communications. This will increase underwater communications performance (throughput and range) by over an order of magnitude from what is achievable today because of the use of high performance commercially available components

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and telecommunications signal processing technology. Significant technical obstacles include up- and down-conversion efficiencies and severe attenuation in water.

(U) Program Plans:
FY 2009 Plans:
- Develop technologies to address acceptance angle limitations.
- Design and fabricate photonic frequency converter.
- Measure converter photon conversion efficiency and gain in laboratory environments.
- Model system performance in simulated ocean environment.

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

(U) The Surface Warfare Automated Shiphandling (SWASH) program examined 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 sought 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.

(U) Program Plans:
FY 2007 Accomplishments:
- Refined prediction capability for ocean wave fields.

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

(U) The Hypersonics Flight Demonstration program (HyFly) developed and demonstrated advanced technologies for hypersonic flight. The ultimate goal of the program was to demonstrate vehicle performance that could lead to an operational tactical surface launched missile range of 600 nautical miles. Specifically, the program demonstrated an F-15 launched missile configuration with a range of 400 nautical miles, a 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 included the scramjet propulsion system, lightweight, high-temperature materials for both aerodynamic and propulsion structures, and guidance and control in the h**y**personic flight regime. Recently demonstrated performance in ground testing of the dual combustion ramjet engine coupled with advances in high temperature, lightweight aerospace materials were enabling technologies for this program. The core program focused on development and demonstration of capabilities requisite for an operational weapon. 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:

FY 2007 Accomplishments:

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

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

(U) The High Efficiency Distributed Lighting (HEDLight) program fundamentally changed 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 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 included 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 combined the light source, the optical coupler, and fiber-luminaire. A Memorandum of Agreement (MOA) is transitioning 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:

FY 2007 Accomplishments:

- 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.
- Demonstrated a limited scale HEDLight system installed on two U.S. Navy ships.
- 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.

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(U) Other Program Funding Summary Cost:

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

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Advanced Land Systems Technology TT-04	49.853	60.286	82.421	83.580	79.752	80.147	79.354

(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.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Novel Sensors for Force Protection	9.992	7.071	7.000

(U) The Novel Sensors for Force Protection program is exploring and developing 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 intent is to enhance the ability of U.S. warfighters to sense the presence of explosives or shielded nuclear materials, as well as enhance the ability to identify individuals involved in the manufacture and/or use of these materials.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed data processing techniques for quantification of emanation signatures.
- Determined the relative contribution of Major Histocompatibility Complex (MHC)-determined signatures and non-genetic background signals.

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FY 2008 Plans:
- Perform studies to identify the specific regions of the mouse and human genome associated with odorant production in mice and humans.
- Demonstrate a breadboard pulsed d(D,n) neutron source; with 1-5M neutron pulses at 5 KHZ; a flux of 10M neutrons/second with ion energies with >1.15Mev and forward scattered neutrons with a half cone angle of 80 degrees.

FY 2009 Plans:
- Develop and demonstrate a compact field portable directional neutron source for stand-off detection of explosives and for nuclear materials.
- Develop operational prototype for explosives detection in breath.

	FY 2007	FY 2008	FY 2009
Dynamic Optical Tags (DOTS)	0.545	1.897	0.000

(U) Based on the technical successes and demonstrated operational relevance of DARPA's now completed Optical Tags program, the Dynamic Optical Tags (DOTS) 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:

FY 2007 Accomplishments:
- Demonstrated performance in the field at militarily useful data rates and ranges.

FY 2008 Plans:
- Develop airborne interrogation systems.
- Develop novel emplacement technologies.

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– Integrate and test components in a fully functional configuration.

	FY 2007	FY 2008	FY 2009
Guided Projectiles	9.319	3.857	6.000

(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 developed low-cost, non-imaging optical seeker/guidance technology exploiting technology development in the visible and infrared spectrum, designed to replace the current 60mm mortar fuse and improve firing precision. Additionally, research was done with explosives to improve the effectiveness of 60mm explosive rounds. The goal was to develop a 60mm projectile with the effectiveness of a 105mm high explosive projectile. In addition, the technology developed for the 60mm projectile was investigated for application to the 81mm and 120mm mortars to increase the accuracy and effectiveness of all fielded mortar rounds at a low cost. This program will now leverage the innovative low-cost optical seeker technology to develop an affordable fuse-guidance package that converts a conventional 81mm or 120mm mortar round into a precision-guided munition. This program will further extend this development to the development of laser-guided munition systems wing-dropped from tactical UAVs and guidable from the on-board laser designator to any target within the field of view (FOV) of the designator. Critical developments supporting this program include component or packaging development technologies that enable the guidance sensors and actuators to sustain the 20-40,000g peak launch stresses, and the development of guidance systems that integrate low-cost GPS and terminal laser lock-on.

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(U) Program Plans:

FY 2007 Accomplishments:

- Conducted laboratory shock testing to characterize the conditions experienced at launch and began the process of verifying internal component survivability.
- Developed an aerodynamic model of the 60mm mortar round. Validated this model through ballistic launch testing.
- Developed and fabricated 60mm controlled test vehicle (CTV) rounds to verify aerodynamic controllability in flight and survivability of internal components during launch. Conducted CTV launch tests verifying significant portions of the design.
- Completed successful bench testing for the semi-active laser seeker, fabricating and successfully bench testing its analog detector chip subcomponent.

FY 2008 Plans:

- Develop a low-cost optical seeker applicable to 81mm and 120mm mortar rounds and unmanned air vehicle (UAV)-borne munitions.
- Design and develop the other components of the fuse-guidance packages for these rounds, to include electronic and mechanical components, as well as guidance software.
- Perform system engineering activities to derive design requirements for integration and employment on tactical UAVs.

FY 2009 Plans:

- Fabricate and test seeker-guidance systems on large caliber (81mm or 120mm) mortar rounds.
- Demonstrate full system aerodynamic control and less than 10% reduction in maximum range.
- Demonstrate guided round accuracy.
- Begin integrating the UAV-borne rounds with the tactical UAV platforms selected to employ them.

	FY 2007	FY 2008	FY 2009
Networking Extreme Environments (NetEx)	2.995	1.000	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

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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:

FY 2007 Accomplishments:

- Developed and demonstrated power-efficient UWB communication systems that can coexist with legacy systems and intentional jammers.
- Developed algorithms, protocols, and distributed control for robust, scalable ad-hoc networking that effectively shares the UWB channel among non-cooperating UWB systems.
- Demonstrated the application of the NetEx UWB-based communication network to a wireless intercom system for intra-vehicle squad-level communications.

FY 2008 Plans:

- Build prototype NetEx UWB-based communication network system and test in operationally relevant field demonstration.

	FY 2007	FY 2008	FY 2009
Magneto Hydrodynamic Explosive Munition (MAHEM)	3.035	3.126	2.400

(U) The Magneto Hydrodynamic Explosive Munition (MAHEM) program will demonstrate compressed magnetic flux generator (CMFG)-driven magneto hydrodynamically formed metal jets and self-forging penetrators (SFP) with significantly improved performance over explosively formed jets and fragments. Explosively formed jets (EFJ) and 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 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

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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:

FY 2007 Accomplishments:

- Completed single compressed magnetic flux generator (CMFG) and magnetic hydrodynamic explosive munition (MAHEM) concept designs.
- Tested helical CMFG designs at low-power.

FY 2008 Plans:

- Develop MAHEM variants tailored to mission-specific requirements.
- Develop and conduct experiments to demonstrate feasibility 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.
- Evaluate alternative CMFG capabilities and effects

FY 2009 Plans:

- Test fire from AT4 tube to demonstrate aerostability and setback.
- Transition to munitions development centers.

	FY 2007	FY 2008	FY 2009
Compact Military Engines	2.430	1.170	0.000

(U) As military systems become more mobile, 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

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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.

(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated critical technologies.
- Completed prototype engine design, manufacture, and assembly.

FY 2008 Plans:

- Test prototype engine to demonstrate continuous operation at substantial power levels.

	FY 2007	FY 2008	FY 2009
Crosshairs	10.900	14.400	12.000

(U) The Crosshairs program seeks to develop a vehicle mounted, threat detection, and countermeasure system that will detect, locate, and engage enemy shooters against 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 initial development and testing of the Crosshairs sensor system. Phase IA culminated with a static live fire test to determine the most effective candidate sensor system. During Phase IB, enhancements were made to the sensor system for on the move performance, and on the move testing against multiple threats was conducted. DARPA and the U.S. Army Rapid Equipping Force (REF) have entered into an MOA for Phase IIA. Phase IIA consists of a moving demonstration of the hardened, packaged, and enhanced Phase I sensor system on two networked HMMWVs (Humvee), integration with candidate response systems, and testing and evaluation of the complete systems in relevant environments. The goal of Phase IIB will be to integrate the final Crosshairs system with an appropriate active protection system (APS).

(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 v2.5 acoustic gunfire detection system. Radar detection of all other threats will be made using the Crosscue radar. The Crosscue radar is a dual mode, continuous wave, and pulsed

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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. Additionally, the program is investigating the feasibility of a variety of technologies to detect enemy shooters before the firing of a weapon. Promising technologies, such as the C-Sniper program, budgeted in this PE/Project, will be integrated with the Crosshairs capability to ensure maximum protection against enemy shooters.

(U) Program Plans:

FY 2007 Accomplishments:

- Identified and developed ultra-fast sensors and algorithms to detect and track multiple threats in near real time for static testing.
- Performed component testing and conducted detection and shooter localization demonstrations.

FY 2008 Plans:

- Analyze data and integrate sensors and response system for initial on the move capabilities.
- Perform on the move tests with the Vanguard vehicle.
- Enhance on the move sensor system capabilities to include decreasing false alarm and false tracks.
- Develop form factor and harden sensor system.
- Identify second overhead weapons station for integration on the Crosshairs vehicle.

FY 2009 Plans:

- Perform on the move testing of the integrated Crosshairs system against a variety of threats.
- Demonstrate the final system capability in live fire tests.
- Demonstrate networking capability between two Crosshairs sensor systems.

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	FY 2007	FY 2008	FY 2009
RPGNets	1.330	3.514	6.621

(U) The goal of the RPGNets program is to apply a rigorous scientific approach to the characterization of the interactions of special high-capability nets to dud, break, or otherwise disable rocket propelled grenades (RPGs). This program builds upon observed, but not well understood, capabilities of certain nets to disable RPGs in field tests and will provide models supplemented by high-precision experiments that characterize net performance and allow determination of optimal net systems for both ground vehicles and helicopters. The defined net systems will be tested in an extensive live fire program. If successful, they will be incorporated into defensive systems currently under development as a low-cost, low collateral damage RPG defense mechanism.

(U) Program Plans:

FY 2007 Accomplishments:

- Completed computer modeling of initial concept/net configurations.
- Conducted live fire testing of initial concept/net configurations.

FY 2008 Plans:

- Develop and validate models for fuse interaction, ogive crushing, and breaking of RPGs by nets.
- Design and fabricate instrumented RPG simulants for use in high-resolution experiments.

FY 2009 Plans:

- Based on model results, perform a series of high-resolution experiments in the Rapid Test Facility to extend and validate model performance.
- Define optimum net systems for RPG defeat and perform rigorous live fire field-testing.

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	FY 2007	FY 2008	FY 2009
Counter Improvised Explosives Laboratories (CIEL)	1.567	1.209	0.000

(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:

FY 2007 Accomplishments:

- Developed a chemo-sensor that provides a clear and fast identification of the target explosive.
- Successful field tests performed to validate the methods for desensitizing and neutralizing explosives.

FY 2008 Plans:

- Identify a physical method that will neutralize/desensitize bulk explosive materials.
- Conduct feasibility demonstrations to neutralize/desensitize up to 1 Kg of the pure target explosive and mixtures.
- Optimize and demonstrate the sensor on pure target explosives and mixtures.

	FY 2007	FY 2008	FY 2009
Maneuver and Control on the Urban Battlefield	2.300	2.500	0.000

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

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(U) Program Plans:

FY 2007 Accomplishments:

– Initiated design and development of a rescue spreader end effector, energy storage and power delivery components for a portable, lightweight system.

FY 2008 Plans:

– Initiate integration of energy storage, power delivery, and end effector components into a single portable lightweight rescue spreader.

	FY 2007	FY 2008	FY 2009
Recognize Improvised Explosive Devices and Report (RIEDAR)	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 various devices.

(U) Program Plans:

FY 2008 Plans:

– Demonstrate laser filamentation at 100 meters using low power lasers.

– Demonstrate operation of compact, tunable lasers from deep ultraviolet (UV) to near infrared (NIR).

FY 2009 Plans:

– Determine plume characteristics of explosive species in real meterological scenarios.

– Demonstrate compact, tunable lasers from deep UV to NIR in ruggedized structure.

	FY 2007	FY 2008	FY 2009
Lightweight Ceramic Armor (LCA)	0.000	4.500	6.500

(U) The Lightweight Ceramic Armor (LCA) program will leverage recent breakthroughs in novel ceramic fabrication processes developed in the Materials Processing Technology project to drive a dramatic performance shift in the tradeoff between weight and ballistic projectile protection

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of body armor. Currently fielded B4C body armor is heavy and limited in the diversity of shapes that may be molded. Its weight and bulk limit a soldier's agility and mobility, and its cost 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 reduction in 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, and scale up of the fabrication technology to body armor size scale articles. The program will additionally investigate the potential for the development of dramatically improved ballistic armored headgear along these same lines.

(U) Program Plans:

FY 2008 Plans:

- Develop lightweight ceramic armor with high dynamic tensile stress to effectively dissipate shock waves.
- Investigate backing materials or materials systems for optimized energy dissipation characteristics when used in combination with this new class of ceramics.
- Develop improved processing of initial ceramic powder materials for improved ceramic performance, part yield, and yielded cost.
- Develop and model a scalable manufacturing process design for a pilot scale fabrication system capable of producing sufficient high performance ceramic material plates to support the end-manufacture of 1,000 systems per month.
- Validate an initial 15% reduction in weight for equal performance compared to currently fielded Enhanced Small Arms Protective Inserts (ESAPI) armor inserts.

FY 2009 Plans:

- Optimize integrated backing materials - ceramic armor materials systems for minimum weight at ESAPI ballistic performance.
- Evaluate the characteristics of an optimized LCA armor system optimized for minimum weight at ESAPI ballistic performance.
- Investigate the potential for significantly improved ballistic characteristics of meta-structured ceramic systems incorporating multiple materials layers in a monolithic plate.
- Validate a 30% reduction in weight for equal performance compared to currently fielded ESAPI armor inserts.
- Develop and evaluate initial concepts for ballistic headgear incorporating the LCA materials.
- Demonstrate key manufacturing steps at pilot scale throughput with consistent and reliable yielded ceramic part performance.

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	FY 2007	FY 2008	FY 2009
Small Combat Vehicle with Robotic Automation	0.000	2.500	3.000

(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 and semi-autonomous navigation, 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:

FY 2008 Plans:

- Conduct initial studies and develop vehicle automation concepts.
- Conduct experiments and evaluations of candidate technologies.

FY 2009 Plans:

- Initiate preliminary designs.

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	FY 2007	FY 2008	FY 2009
Helicopter ALert and Threat Termination (HALTT)	0.000	3.030	7.000

(U) The Helicopter ALert and Threat Tracking (HALTT) program, an outgrowth of the Crosshairs program, will provide Army and Navy/Marine helicopters with a way to detect small arms and RPG attacks, improve their ability to respond, and provide affordable defeat of RPGs or other rockets. System effectiveness with emphasis on low false alarm rates is critical. The program goal is to successfully demonstrate protection of helicopters by automatic threat detection of small arms and RPGs, shooter localization, and threat mitigation/defeat.

(U) Program Plans:

FY 2008 Plans:

- Conduct component testing of the acoustic system during flight testing.
- Complete prototype system level integration with existing aircraft survivability equipment.
- Examine rocket threat detection and termination.

FY 2009 Plans:

- Conduct final acoustic component testing and demonstrate the prototype system.
- Develop HALTT system preliminary design and system integration plan.
- Perform live fire testing of individual subsystems.

	FY 2007	FY 2008	FY 2009
C-Sniper	0.000	6.712	11.600

(U) Based on promising results obtained under the Crosshairs program, the C-Sniper effort will develop the capability to detect and neutralize enemy snipers before they can engage U.S. Forces. The program will lead to the delivery of a field testable prototype suitable for experimentation as an integrated part of the DARPA Crosshairs system. The C-Sniper system will augment the Crosshairs system by identifying threats before they can fire. The enemy snipers may be operating both with, and without, telescopic sights, and other optical systems in highly cluttered urban environments. The C-Sniper system will operate day and night from a moving military vehicle and provide the operator with sufficient

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information to make a timely engagement decision. Once the decision is made, the C-Sniper will provide data and control to point and track the on-board weapon on the selected target. The final decision to fire the weapon will be left to the operator.

(U) Program Plans

FY 2008 Plans:

– Conduct feasibility studies of promising technologies to detect enemy shooters before the firing of a weapon.

FY 2009 Plans:

– Develop the key technologies (laser system, sensor head, and system processing designs).
– Develop the interfaces of the sensor system to integrate with Crosshairs.
– Conduct systems integration and test on stationary vehicle.
– Develop and incorporate system design enhancements required for a moving vehicle.
– Develop, deliver and demonstrate the operation of C-Sniper on moving vehicles.
– Demonstrate system capability to correctly detect optical systems in highly cluttered urban environment.

	FY 2007	FY 2008	FY 2009
Rocket Propelled Grenade (RPG) Pre-launch Detection and Cueing	0.000	0.000	3.000

(U) The Rocket Propelled Grenade (RPG) Pre-launch Detection and Cueing program will enable the development of an omni directional, visual, and vehicle mounted surveillance system for threat detection using cognitive swarm recognition technology to rapidly detect and identify the locations of attackers with RPGs before they are launched. During the first phase of the program, a system will be demonstrated capable of 360 degree coverage and detection rates of greater than 95%. Minimizing false alarms and false positives will be key, as will be true day/night operation and the simultaneous identification of up to five threats.

(U) Program Plans

FY 2009 Plans:

– Develop and mature detection and classification algorithms.
– Breadboard test of detection and classification algorithms.

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– Perform a system demonstration with stationary cameras.

	FY 2007	FY 2008	FY 2009
Micropower Engine	0.000	0.000	2.900

(U) The goal of the Micropower Engine program is to significantly improve the cost, weight, and overall capability of man-portable power systems by developing a small power system built around a fuel-breathing, hydrocarbon-fueled, recuperated, expander-cycle micro-scale turbine engine. This system can substitute for a standard battery, such as the BA5590, in military man-portable power applications. The availability of greater man-portable power increases the potential capability of man-portable electronic systems. It is well-established that power systems built around liquid-hydrocarbon-fueled micro-scale heat engines offer the potential of an order of magnitude (10x-50x) leap in energy density over chemical batteries. Such designs have not been reduced to practice because of the high rotational speed bearing limits at the microscale. The proposed engine is "fuel-breathing" rather than "air-breathing," using liquid hydrocarbon fuel, rather than air, as the working fluid of its thermodynamic cycle thus enabling compression at much lower rotational speeds.

(U) Program Plans:
FY 2009 Plans:
– Conduct a trade study determining engine performance through various size ranges.
– Demonstrate novel compressor/injector at mesoscale.
– Design a microscale engine to the preliminary level.

	FY 2007	FY 2008	FY 2009
Defeat of Explosively Formed Projectiles (DEFP)	0.000	0.000	3.500

(U) The objective of the Defeat of Explosively formed Projectiles (DEFP) program is to develop technologies to counter Explosively Formed Projectiles (EFPs). EFPs have become the "threat of the future" for insurgent forces as they can penetrate all of today's armored vehicles including tanks. Since EFPs penetrate largely by virtue of their momentum, they are not susceptible to simple forms of reactive armor. New

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approaches to be investigated include a new generation of "smart armor" that combines sub-millisecond sensing and processing with directable explosively driven counter-EFP devices. This armor will reduce, re-direct, and disperse the penetrating elements of the EFP to a point such that the base armor of a Bradley Fighting Vehicle would not be perforated. This program seeks to provide this capability at an added weight of less than 40 lbs per square foot.

(U) Program Plans:
FY 2009 Plans:
- Demonstrate sensing, processing, and ballistic components.
- Perform component live fire tests.

	FY 2007	FY 2008	FY 2009
Silversword	0.000	0.000	4.100

(U) The Silversword program will develop power-source and radio frequency (RF) component technologies for multi-pulse, ultra-compact, wideband, gigawatt microwave sources.

(U) Program Plans:
FY 2009 Plans:
- Employ RF munitions at gigawatt power levels to irradiate electronic systems.
- Configure a Blumlein-driven source to defeat the electronic front ends of remotely-triggered devices and to investigate the susceptibility of military, commercial, and consumer electronics.

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

(U) Established Hypersonics Advanced Technology initiatives.

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

(U) Researched extreme light sources.

	FY 2007	FY 2008	FY 2009
Optical Sensor System	1.000	0.800	0.000

(U) Researched optical sensors.

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

(U) Researched HazMat Decontamination on a molecular approach .

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Advanced Tactical Technology TT-06	103.715	113.550	114.421	84.028	59.820	59.820	60.314

(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 2007	FY 2008	FY 2009
Super High Efficiency Diode Sources (SHEDS)	4.000	4.000	4.000

(U) The goal of the Super High Efficiency Diode Sources (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 100 kW class diode pumped solid state lasers. The goal of the SHEDS Plus Program is to retain high wall-plug efficiency of over 70% while producing diode bars with 200 W/bar-cm, lifetimes of greater than 1000 hours (hrs.). In addition, SHEDS Plus plans allows operation at the increased inlet water cooling temperatures exceeding 55°C which provides for 2 or 3-fold higher thermal management efficiency in many applications.

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(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated single edge-emitting laser diodes operating at record-high efficiency.
- Demonstrated a stack of edge-emitting laser diode bars operating at high-power and record-high efficiency.
- Demonstrated an array of vertical-external-cavity surface-emitting laser (VCSEL) laser diodes operating at record efficiency.

FY 2008 Plans:

- Demonstrate an array of VCSEL laser diodes operating at high-power density and high efficiency.
- Demonstrate a quantum dot laser diode bar operating at record-high efficiency.
- Establish methods to increase diode power output by increasing laser cavity length without sacrificing efficiency.
- Demonstrate improvements in diode lifetime through suppression of filamentation and instabilities.
- Enable diode operation at increased inlet water cooling temperatures.

FY 2009 Plans:

- Demonstrate a quantum dot laser diode bar operating at high-power and record-high efficiency.
- Demonstrate diode bar lifetime greater than 100 hours.
- Demonstrate power per bar above 85 W/Bar.
- Increase working coolant temperature beyond 35°C.

	FY 2007	FY 2008	FY 2009
High Energy Liquid Laser Area Defense System (HELLADS)	29.000	38.500	40.608

(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 <5 kg/kW, HELLADS will enable high-energy lasers (HELs) to be integrated onto tactical aircraft and will significantly increase engagement ranges compared to ground-based systems. 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 fabricated and will demonstrate an output power of >34 kW. A test cell that represents one-half of the unit cell laser has been fabricated and used to characterize system losses and diode performance and reliability. The test cell is being expanded to a unit

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cell. Based on the results of the unit cell 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) Program Plans:

FY 2007 Accomplishments:

- Designed and fabricated a test cell.
- Completed diode stack life testing of both protected and unprotected diodes in HELLADS environment.
- Completed characterization of laser losses.
- Initiated development of the laser weapon system demonstrator components.

FY 2008 Plans:

- Fabricate a test head and characterize the optical performance of the unit cell.
- Complete preliminary design of a 150 kW laser weapon system demonstrator.

FY 2009 Plans:

- Complete a unit cell laser module with integrated power and thermal management subsystems and demonstrate power, beam quality, run-time, weight, and volume.
- Complete detailed design of a 150 kW laser weapon system demonstrator.

	FY 2007	FY 2008	FY 2009
Aero-Adaptive/Aero-Optic Beam Control (ABC)*	0.000	4.000	5.000

*Previously part of High Energy Liquid Laser Area Defense System.

(U) The goal of the Aero-Adaptive/Aero-Optic 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

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regard. The program will also explore the ability of the flow control system to be synchronized with 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 will be undertaken.

(U) Program Plans:

FY 2008 Plans:

- Initiate trade studies and computational fluid dynamics (CFD) analyses.
- Characterize turret aero-optical performance with CFD analysis and small-scale wind tunnel testing.
- Downselect to preferred turret and flow control configuration.

FY 2009 Plans:

- Use CFD to optimize blowing slot configuration.
- Assess wavefront measurements for a range of pointing angles.
- Downselect flow control actuation technique.

	FY 2007	FY 2008	FY 2009
High Performance Algorithm Development	16.924	15.931	10.200

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

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(U) Program Plans:

FY 2007 Accomplishments:

- Strategy developed for automatic generation of low power, minimal area, fast convolution algorithms that are developed in less than 1/10th the time of hand tuned engineering experts with better performance.
- Transitioned methods to industry for the generation of fast Fourier Transform codes.
- Implemented strategy for sparse fast multi-pole methods that lead to the co-design of optimal codes and a board based upon field programmable gate arrays.
- Demonstrated superiority of time reversal methods compared to conventional matched filtering processing for situations involving multipath clutter.
- Developed principled multi-scale graph theoretical methods that decompose non-linear systems into smaller systems.
- Demonstrated methods that reduce the number of experiments required to map a non-linear dynamical system.
- Demonstrated new methods to design dynamics of mobile sensors to support surveillance in the presence of sensor and platform uncertainties.
- Discovered high-dimensional patterns in the statistics of natural images using methodology developed in the topological data analysis program.
- Developed novel, non-linear compression schemes based on high-dimensional topological patterns.
- Demonstrated application of computational topology to information representation in the brain.
- Constructed novel, non-linear, non-invasive medical statistics to assist doctors in understanding risks when assessing patients in intensive and critical care situations.
- Developed a software tool to analyze algorithms for representation based on clustering.
- Established a precise correspondence between theoretical mathematics and quantum physics.

FY 2008 Plans:

- Extend methods from kernels to end-to-end applications including JPEG2000, Viterbi coding, and Synthetic Aperture Radar (SAR) processing.
- Extend time reversal theory to form complete images of targets in multipath environments.
- Test hypothesis that multipath scattering will enable portions of the target that are not illuminated to be imaged.
- Develop test range facility and clutter environment to support experimentation at Ka band.

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- Extend methods to cope with nonlinear systems with dimensionality greater than 10,000 degrees of freedom. Accelerate the methods to achieve 100x performance over particle filtering and Monte Carlo sampling. Demonstrate the method in 2.5 dimensions with over 10,000 degrees of freedom.
- Develop novel clustering algorithms that address stochasticity and uncertainty.
- Expand software tool capability and functionality to address complex datasets of military importance.
- Inject novel mathematical tools into quantum physics calculations.
- Develop new mathematical approaches to approximate infinite calculations by polynomial ones.
- Demonstrate new mathematical results in communications networks and number theory based on novel geometric methods.
- Demonstrate improved performance of geometrically inspired algorithms for communication networks, tomographic inversion, and numerical solutions of partial differential equations.

FY 2009 Plans:

- Demonstrate using the Discovery and Exploitation of Structure in Algorithms tools that non-expert users can design end-to-end systems for JPEG2000, Viterbi coding, and SAR that are designed in $1/10^{th}$ the time of expert designers and that have equivalent performance.
- Extend DESA tool suite to other common signal processing and image formation algorithms.
- Extend time reversal methods to acoustic channels and increase the computational speed of the Green's function by 100.
- Apply time reversal methods to detect and image targets in clutter that can not detected by conventional processing.
- Extract images of targets in clutter and export the target chits to an automatic target recognition and compare performance of the automatic target recognition system against and image of the same target in the clear.
- Apply the Robust Uncertainty Management developed methods to a DARPA specified cooperative surveillance problem in which the sensors have stochastic performance, probabilistic data links, and requirements for multiple looks.
- Use topological tools previously developed to analyze higher-order datasets in biology, sensing, neuroscience, military, and community networks.
- Establish and exploit new relations between topology, number theory, and symmetry groups of fundamental particles.
- Tie advances in pure mathematics to defense applications in cryptography, quantum sciences, materials, and nano-level structures.
- Develop a quantitative methodology in the area of information propagation and understanding for the military and coalition environment, relying on observations from neuroscience, cognitive science and social networking.
- Develop and test new algorithms in which geometry is the starting point for design.

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– Demonstrate capabilities on test bed problems aligned with DoD mission that are not certifiably attainable by approaches currently in use.

	FY 2007	FY 2008	FY 2009
Integrated Sensing and Processing	10.000	4.373	7.500

(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, and novel approaches to multiplexed hyper-spectral chemical/biochemical sensing systems.

(U) Program Plans:

FY 2007 Accomplishments:

– Demonstrated that closed loop adaptive processing led to a 7x reduction in the number of pixels sensed in both variable acuity and hyper-spectral scenarios relative to conventional processing.
– Developed self-localizing, power aware, 1 bit processing, non-myopic scheduling for motes and demonstrated the ability of the mote field to detect and track slow moving targets with 10x power reduction relative to existing methods.
– Developed, tested, and verified the performance of a new analog imaging chip for embedded low-power applications such as missile seekers.
– Developed new representations for scalar fields on the sphere which lead to file sizes that are 100x smaller than conventional representations with no loss of fidelity in applications.
– Developed new contrast and illumination-independent representations for images that lead to automated registration (better than 0.5 pixels) and mosaicking at 2 hertz (Hz).

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- Created new file structure to support streaming video for disadvantaged users at 100x compression with no impact on visual quality developed.
- Developed a robust target enumeration theory and corresponding algorithms for distributed dynamical sensor networks.
- Developed novel pursuit and capture criteria for multiple pursuers that works in non-convex domains, using comparison geometry.
- Determined the composition of the chemical specifications.

FY 2008 Plans:

- Develop theory of compressed sensing for small targets using imaging systems.
- Demonstrate in simulation detection and track of small targets comparable to baseline detect and track with on the order of N (O(N)) fewer measurements.
- Evaluation of the FY 07 Geospatial Representation and Analysis (GEO) products by National Geospatial-Intelligence Agency (NGA).
- Extend the registration methods to 0.1 pixel registration error and operation at 15 Hz.
- Extract three dimensional structure from video at 3 Hz.
- Develop meshless wavelet basis and topological representations that yield 50x improvement over conventional representations with less than 1% distortion in end user applications.
- Expand FY 07 accomplishments by addressing stochasticity and uncertainty in DoD sensing applications.
- Extend theory of configuration spaces to information spaces for network systems and sensing applications.
- Determine the material requirements with regard to several dimensions of operation and use.

FY 2009 Plans:

- Extend theory of compressed sensing for small targets using imaging systems to determine sparse bases and provide design for a next generation sensor.
- Demonstrate detection and tracking of small targets comparable to baseline detect and track with significantly fewer measurements.
- Transition FY 08 products to NGA.
- Extend registration methods to 0.1 pixel registration error and operation at 30 Hz.
- Extract three-dimensional structure from video at 30 Hz.
- Develop meshless wavelet basis and topological representations that yield 100x improvement over conventional representations with less than 0.5% distortion in end user applications.
- Demonstrate that Sensor Topology for Minimal Planning provides coverage, encirclement, and pursuit capabilities in a real DoD distributed sensing scenario that are not certifiably attainable by approaches currently in use.

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	FY 2007	FY 2008	FY 2009
Training Superiority	8.718	9.791	13.071

(U) The Training Superiority program will change the paradigm for military training by creating new approaches to increase technical competence. 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, this thrust will scale-up new digital tutor methodologies, deliver these to a large cohort of warfighters, and demonstrate a convincing benefit compared to standard training in an operational environment.

(U) Program Plans:

FY 2007 Accomplishments:

- Transitioned user-authorable PC-based small unit training tool, *DARWARS Ambush!*, to the Army (>20,000 Soldiers, Marines and Airmen trained this year).
- Developed new scenarios to demonstrate the potential for training non-kinetic operations with user-authorable PC simulation.
- Completed transition of Tactical Language and Culture Training to Special Forces and the U.S. Marine Corps.
- Competed Tactical Pashto language and cultural trainer.
- Transitioned multi-user training architecture to the Joint Forces Command and the OSD's Advanced Distributed Learning Initiative program.
- Initiated Education Dominance program, in cooperation with the Navy, to develop digital tutors that teach better than the best classroom tutors.
- Delivered an A-10C part task trainer to the Air Force which is currently being used to train pilots at Nellis AFB.
- Delivered an Electronic Weapons Officer training capability to the Air Force which is currently being used to train students at Randolph AFB.

FY 2008 Plans:

- Create compelling, digital tutor training for Navy information technicians that trains as well as the best human tutors.
- Design experiment to demonstrate the effectiveness of those so trained in a fleet exercise: the Infantry Warrior Simulation Cup.

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FY 2009 Plans:
- Demonstrate 40-hour Digital Tutor, teaching one week of content, in a production software configuration.
- Port three weeks of content from a human-tutored course to the Digital Tutor and test in a laboratory setting.
- Conduct and evaluate the first Information Warfare Cup (IWARS Cup) using the human-tutored team.
- Enable the presentation of synthetic opposition forces (OPFOR) within the real world training environment.

	FY 2007	FY 2008	FY 2009
RealWorld*	0.000	9.200	12.125

*Previously funded under Training Superiority.

(U) The RealWorld program exploits technical innovation and integration to provide any U.S. warfighter with the ability to open a laptop computer and rehearse a specific mission in the relevant geo-specific terrain, with realistic physics. Because the system will be scalable and distributed, warfighters can practice by themselves, in small groups, or with as many other warfighters as needed for the mission over a local or distributed network, and across all relevant platforms (dismounts, vehicles, helicopters, fast movers). Most important is the understanding that RealWorld is not a simulation; it is a simulation builder with applications across the spectrum of modern kinetic and non-kinetic warfare. The program is building tools that allow warfighters to rapidly and easily build their own missions though the introduction of new methodology for building simulation software. These methodologies and adherence to a highly modular approach will cause a fundamental paradigm shift in the acquisition, as well as the construction, of DoD modeling and simulation products.

(U) Program Plans:

FY 2008 Plans:
- Demonstrate automated geo-specific terrain from digital terrain elevation data.
- Demonstrate scalability to 250 live network participants running on a single server, thus surpassing current DoD multi-player capacity.
- Demonstrate integration of Newtonian physics.
- Apply RealWorld simulation builder to digital cockpit training.
- Transition RealWorld Air component to Air Force as the universal trainer for A-10C.

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- Apply RealWorld simulation builder to electronic warfare applications. Transition RealWorld Electronic Weapons Officer component to Air Force.
- Scale to 500 entities.
- Demonstrate 3-D positional audio, multi-channel audio and physical modeling of communications jamming effects including multi-spectrum and frequency jamming.
- Implement an artificial intelligence (AI) Abstraction layer allowing the future integration of disparate AI systems.
- Develop a rendering solution capable of supporting hardware that can render images ranging from 1080p high definition to PlayStation Portable quality.
- Ingest 1 sq. km. of government terrain data into a physics based 3-D real-time software environment in thirty minutes.
- Ingest 360 sq. km. of government terrain data into a physics based 3-D real-time software environment in four hours.
- Create up to 38,000 sq. km of terrain data for air specific missions, anywhere in the world, in one hour.
- Automatically generate the interior (including furniture and stairways) and exterior of a geo-typical building of any size or footprint in under 5 minutes that includes building material types by zip code.
- Initiate development of a universal medic simulation builder.
- Demonstrate utility as a trainer for at least one SOCOM application.

FY 2009 Plans:

- Scale to 1000 entities.
- Demonstrate dynamic path finding such that entities will be able to maneuver in a terrain deformed geo-specific area.
- Integrate meteorological capability so real-time weather can be imported into training and rehearsal scenarios.
- Demonstrate integration of data from Google Earth.
- Integrate a full Newtonian physics modeling engine in a real-time 3-D engine in both a hardware enhanced and software only modality.
- Transform pictures taken by a cell phone camera into a 3-D model capable of being ingested by a real-time 3-D engine with an accuracy of one or less.
- Transform a laser imaging detection and ranging (LIDAR) data collection set into a 3-D model (using topology graph analysis and parametric model fitting) capable of being utilized by a real-time 3-D engine.
- Ingest up to 1 sp. mile of LIDAR terrain data and render 3-D models in under one hour.
- Transition to military customers.

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	FY 2007	FY 2008	FY 2009
Air Laser	4.739	1.000	2.000

(U) The Air Laser program investigated the potential for a high energy laser concept based on direct diode pumping of liquid nitrogen. The Air Laser concept sought to combine the advantages of chemical and solid state lasers while minimizing the disadvantages. It used liquid nitrogen as the gain medium and as the diode array coolant, resulting in the reduction of a separate thermal control system. Use of efficient, high-power diode pump sources resulted in a compact device much smaller than either chemical or solid state lasers, and its pulse length was variable from continuous to sub-picosecond, allowing flexibility in weapons effects.

(U) Program Plans:

FY 2007 Accomplishments:

- Performed system/utility analyses.
- Conducted laboratory experiments to characterize high-power cryogenic pump lasers.

FY 2008 Plans:

- Develop and demonstrate a 1 kW output power laser design.

FY 2009 Plans:

- Develop a 100 kW laser design.

	FY 2007	FY 2008	FY 2009
Efficient Mid-Wave Infrared Lasers (EMIL)	5.394	8.700	7.900

(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, most commonly based on zinc germanium phosphide.

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(U) The lasers developed in this program will operate across the three relevant bands within the MWIR at 10 W power with wall plug efficiencies of at least 10%. 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 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 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:

FY 2007 Accomplishments:

- Improved wall plug efficiency by 13%.
- Improved continuous wave output power by 22%.
- Observed a 40% reduction in waveguide loss.

FY 2008 Plans:

- Demonstrate the projected efficiency, power and beam quality levels from single-mode Indium Phosphide (InP)-based QCL emitters.
- Demonstrate device mounting modeling and fabrication for reduced electrical and thermal resistance.
- Test final device integration.

FY 2009 Plans:

- Scale the power, in a parallel development, of the efficient individual QCL sources developed previously.
- Demonstrate epitaxial growth and preliminary characterization of final structures.

	FY 2007	FY 2008	FY 2009
Sonic Projector	2.500	5.437	1.000

(U) The goal of the Sonic Projector program is to provide the services 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

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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:

FY 2007 Accomplishments:

– Completed initial feasibility studies.

FY 2008 Plans:

– Conduct design analysis for high-power ultrasonic transducers, and precision beam control and focus for target tracking.

– Create concept of operations and conduct military utility analyses.

FY 2009 Plans:

– Initial lab demonstrations of long-range sonic projector system.

	FY 2007	FY 2008	FY 2009
Revolution in Fiber Lasers (RIFL)	0.000	1.500	2.000

(U) The goal of the Revolution in Fiber Lasers (RIFL) program is to develop multi-kilowatt, single-mode, narrow line-width 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 line-width 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 10 kW. This program will construct stable 100 W, 10-emitter bars (10 W/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.

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(U) Program Plans:

FY 2008 Plans:

- Demonstrate a 1 kW fiber amplifier with array output combining characteristics (i.e., spectral, polarization and spatial characteristics) that support the controlled combining of outputs from arrays of apertures.
- Demonstrate the process for combining the outputs 10 W fiber amplifiers.
- Demonstrate a 30% efficient diode based pump source that drives 2 kW on 400 Om fiber.
- Demonstrate a >2 kW output power F >15% efficient fiber amplifier with many output combining characteristics.
- Demonstrate controlled combining of 10 W fiber amplifiers.

FY 2009 Plans:

- Demonstrate a 40% efficient diode based pump source that drives 3 kW on 400 Om fiber.
- Demonstrate a >4 kW output power, 30% efficient fiber amplifier with array output combining characteristics.

	FY 2007	FY 2008	FY 2009
Coherently Combined High-Power Single-Mode Emitters (COCHISE)	0.000	6.200	6.017

(U) Building upon the preliminary success of the Super High Efficiency Diode Sources (SHEDS) program, the Coherently Combined High-Power Single-Mode Emitters (COCHISE) program will 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 3x more efficient than existing diode-pumped solid-state laser technology, while improving beam quality and increasing far-field, on-axis intensity.

(U) Program Plans:

FY 2008 Plans:

- Demonstrate a diode bar pre-screening technology based on spectral measurements made on each emitter that can detect $<1^{o}C$ temperature changes among these emitters simultaneously and that can detect packaging defects and other manufacturing defects (High Energy Liquid Laser Area Defense System (HELLADS) diode bars).

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- Correlate electrical fault mode detection based on voltage drops at the diode terminals with optical fault mode detection based on spectral splitting in diode or bar emission (>70% correlation).
- Demonstrate that fault mode frequency as detected electrically at the diode bar terminals correlates with diode bar lifetime – use as an additional diode bar pre-screening technology.
- Demonstrate that SHEDS laser diode bar lifetime can be extended beyond 500 hrs. at full efficiency and power with fault mode protection.
- Demonstrate phase control of individual slab-coupled optical waveguide lasers (SCOWL) emitters to >0.1 waves with a compact diode driver containing integrated fault-mode, protection and the ability to cut current to the SCOWL diode in <2 μsec.
- Use fault-mode protection to extend HELLADS diode bar lifetime to >500 hrs. at a cooling water temperature of 55°C.
- Extend HELLADS diode bar lifetime and efficiency fivefold at cooling water temperatures of 65°C and 75°C with fault mode protection.

FY 2009 Plans:

- Demonstrate a stable synthetic bar of 10 SCOWL diodes at 10 W with 1.4x diffraction limited beam quality.
- Demonstrate that a synthetic bar of 10 SCOWL diodes, each powered independently with an intelligent, fault-mode-protected, Complimentary Metal-Oxide Semiconductor-based driver, can be operated coherently in a Talbot cavity and/or other optical cavity geometries that promote self-assembly of a coherent cavity super-mode.

	FY 2007	FY 2008	FY 2009
Architecture for Diode High Energy Laser Systems (ADHELS)	7.000	4.918	0.000

(U) The Architecture for Diode High Energy Laser Systems (ADHELS) 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 four (by allowing the laser diode array to operate at elevated temperatures), increase the diode array lifetime tenfold, and decrease lifecycle costs fivefold. These improvements will be attained for diode laser arrays operating in the infrared, 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

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electrical and optical filamentation within the laser diode and laser diode bars, and then interrupt power to the laser diode system before thermal instabilities can lead to accelerated diode aging and premature diode failure.

(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated all electric coherent power combining of two lasers diodes.
- Demonstrated a surface-emitting distributed feedback (SE-DFB) laser diode operating at high power and high efficiency.

FY 2008 Plans:

- Demonstrate a kilowatt-class high-power laser with high-efficiency and good beam quality.
- Demonstrate a SE-DFB laser diode operating at high-power, high-efficiency and good beam quality.
- Demonstrate volume Bragg gratings suitable for high-power beam combining and good spectral efficiency.
- Demonstrate a kilowatt-class high-power laser with record-high efficiency and excellent beam quality.
- Demonstrate a SE-DFB laser diode operating at high-power, record-high efficiency and excellent beam quality.
- Demonstrate volume Bragg gratings suitable for high-power beam combining and high-spectral efficiency.

	FY 2007	FY 2008	FY 2009
Laser Star	4.000	0.000	0.000

(U) The Laser Star program investigated 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

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tilt. Laser Star explored approaches to overcome these shortfalls including advanced multi-conjugate adaptive optics as well as nonlinear techniques.

(U) Program Plans:
FY 2007 Accomplishments:
- Completed concept design.
- Conducted experiment and analyzed results for integration with atmospheric compensation programs.

	FY 2007	FY 2008	FY 2009
GORGON - High Power Mid-IR Laser	0.000	0.000	3.000

(U) The GORGON – High Power Mid-IR Laser program will develop and integrate advanced laser and detector technologies to provide proactive IRCM capabilities for a variety of airborne platforms as required by the Multi-function Electro-optical Defense of U.S. Aircraft (MEDUSA) program.

(U) Program Plans:
FY 2009 Plans:
- Perform search/interrogate function based on a vertical-external-cavity surface emitting laser (VECSEL) technology.
- Utilize the laser based on double-clad erbium (Er)-doped zirconium barium lanthanide sodium fluoride (ZBLAN) fiber pumped with λ=975 nm laser bars to carry out the search/interrogate function.

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	FY 2007	FY 2008	FY 2009
Coherent Communications, Imaging and Targeting (CCIT)	3.000	0.000	0.000

(U) The Coherent Communications, Imaging and Targeting (CCIT) program pursued 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, and system integration of photonics and high-speed electronics were also explored.

(U) Program Plans:
FY 2007 Accomplishments:
- Completed 64 x 64 device with individually “wired” test pixels.

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

(U) The Rapid Checkpoint Screening program developed and demonstrated 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:
FY 2007 Accomplishments:
- Completed transition of the research programs and findings to the Department of Homeland Security.

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	FY 2007	FY 2008	FY 2009
High Power Fiber Lasers	4.700	0.000	0.000

(U) The High Power Fiber Lasers program developed and demonstrated single mode, single polarization fiber lasers with output powers greater than one kilowatt from a single aperture. High power fiber lasers have the potential to 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, and rockets.

(U) Program Plans:
FY 2007 Accomplishments:
- Demonstrated greater than 100 watt single mode polarized output power from a single large mode-field area fiber.
- Demonstrated greater than 1 kilowatt output power from a single large mode-field area fiber.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Aeronautics Technology TT-07	58.505	52.756	58.158	64.856	67.486	68.105	70.086

(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 2007	FY 2008	FY 2009
Helicopter Quieting	8.872	9.900	7.000

(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 goal of the Helicopter Quieting Program (HQP) is to identify, develop and demonstrate advanced rotor technologies that can dramatically improve the survivability of military rotor systems, with minimal negative impact on performance, affordability, availability and suitability. A critical element toward this goal is to create and demonstrate a physics-based design toolset that enables analytical design of novel rotor systems and rotorcraft for reduced acoustic susceptibility (detection and recognition) by the human threat.

(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. Additionally, the primary limitation of existing computational models is their inability to accurately predict the pressure distribution on a rotor blade and in the flowfield away from the blade. Novel and creative concepts and ideas are being employed in this program for accurate aerodynamic analysis of helicopter rotor airloading, flowfield, and wakes using high-end computational fluid dynamics techniques. The program will investigate multiple advanced, low-noise rotor

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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) This program will also undertake the development of propagation and perception modeling for rotorcraft acoustic signatures within state-of-the-art visualization architectures. Multiple advanced human perception and cueing models will be developed as a part of the integrated acoustic design and analysis environment. The ability of the toolset to accurately characterize the differences in these factors will support design decisions for advanced, low noise rotors and rotorcraft.

(U) Program Plans:

FY 2007 Accomplishments:

– Developed high-fidelity, physics-based rotor acoustic predictive tools, and demonstrated correlation for conventional rotors.

FY 2008 Plans:

– Validate high-fidelity, physics-based rotor acoustic predictive tools for rotors that exhibit complex aerodynamic phenomena atypical of conventional, fielded rotorcraft.
– Identify acoustic design criteria for new rotor system designs based on operational scenarios.

FY 2009 Plans:

– Develop and demonstrate advanced rotor system designs that incorporate reductions in low-frequency, in-plane signatures for increased survivability without significant impact to flight performance.

	FY 2007	FY 2008	FY 2009
Nano-Flapping Air Vehicles	6.956	9.726	8.000

(U) The goal of this program is to develop flapping and rotary air vehicle technology that results in a bio-inspired flapping and rotary air vehicle with less than two inch wingspan and gross take-off 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 and rotary wing aerodynamics, kinematics and flight dynamics, lightweight aeroelastically tailored wing structures,

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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:

FY 2007 Accomplishments:

– Designed and tested first phase flapping and rotary wing geometry and mechanism.
– Investigated and proved feasibility of a high performance airfoil at low Reynolds number.

FY 2008 Plans:

– Demonstrate robust flapping and rotary mechanisms that produce 10 grams of lift, integrate wing design with air vehicle, and reliable multifunctional wing manufacturing principles.
– Develop novel communication and navigation schemes that allow vehicle control both outdoors and indoors.

FY 2009 Plans:

– Fabricate and assemble flight demonstration vehicles and perform flight tests to evaluate flight performance, navigation capability, and system ability to carry out mission.

	FY 2007	FY 2008	FY 2009
Battlefield Helicopter Emulator (BHE)	6.469	8.750	9.321

(U) The goal of the Battlefield Helicopter Emulator (BHE) is to develop a system capable of emulating rotorcraft signatures, compatible with installation as a payload on a small UAV. The system will provide helicopter signature emulation of a variety of battlefield helicopters. BHE could be used for mine clearing/route determination as well as escort missions. An operational system could draw fire from ground based adversaries, and relay the information back to the operator for off-board location and prosecution. The system's capability to defeat threats with an off-board system offers the opportunity to protect a large number of military aircraft assets and crews over long periods without aircraft performance impact. The reduced acoustic perception distance enabled by the BHE system can reduce the risk to Army and SOCOM helicopters

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from ground fire, small arms, rocket-propelled grenades (RPGs), man-portable air defense systems (MANPADS), and anti-helicopter mines (AHMs).

(U) Program Plans:

FY 2007 Accomplishments:

- Developed and tested techniques to demonstrate technological feasibility.
- Developed initial concept of operations.

FY 2008 Plans:

- Identify technical approaches for adequately emulating critical signatures.
- Characterize signatures of battlefield helicopters.
- Develop concepts to emulate battlefield helicopter signatures.
- Develop and test emulator system to demonstrate technological feasibility in a laboratory environment.
- Development of analytical constructive simulation capability to assess performance of proposed technologies and mature key system performance criteria.

FY 2009 Plans:

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

	FY 2007	FY 2008	FY 2009
Distributed Embedded Propulsion	0.000	4.200	5.000

(U) The Distributed Embedded Propulsion program 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

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possible in take-off and landing distance. 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.

(U) Program Plans:
FY 2008 Plans:
- Conduct trade studies on aircraft sizing for short field take-off and landing.
- Evaluate conceptual designs of distributed embedded propulsion concepts and assess aerodynamic performance.

FY 2009 Plans:
- Determine engine requirements for distributed propulsion system.
- Initiate design of distributed embedded propulsion experiments.

	FY 2007	FY 2008	FY 2009
Laminar Flow Flight Demonstration	0.200	3.800	4.800

(U) The Laminar Flow Flight Demonstration effort will explore the development of an extended laminar flow wing, 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 flight-representative 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:
FY 2007 Accomplishments:
- Conducted initial assessment of range of applicability of crossflow control approaches and candidate platforms.

FY 2008 Plans:
- Conduct trade study of impact and design constraints for laminar flow wings.

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FY 2009 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 2007	FY 2008	FY 2009
Unmanned Persistent Parafoil System (UPPS)*	1.000	3.250	1.000

*Formerly Long Endurance Autonomous Powered Powerfoil (LEAPP).

(U) The goal of the Unmanned Persistent Parafoil System (UPPS) program is to develop and integrate the enabling technologies and system capabilities required to demonstrate a vehicle with large payload and long endurance characteristics capable of taking off and landing on the back of a small ship. The enabling technologies are precision guidance, autonomous operations, parafoil aerodynamic performance, and parafoil integration with sensors/antennas. The UPPS 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 UPPS will have flexibility to be deployed rapidly and will be affordable based on modular system design and construction.

(U) Program Plans:

FY 2007 Accomplishments:
- Developed initial prototype and demonstrated feasibility flight performance.

FY 2008 Plans:
- Conduct system level tests for specific missions and concept of operations.

FY 2009 Plans:
- Initiate final program demonstration and prepare for transition.

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	FY 2007	FY 2008	FY 2009
Disc-Rotor Compound Helicopter	0.000	3.000	3.200

(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 take-off 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 Vertical Take-off and Landing (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:

FY 2008 Plans:

- Develop a conceptual design and technical approach.
- Identify, develop, and demonstrate the critical enabling technologies required to meet the performance goals.

FY 2009 Plans:

- Design an integrated scaled concept demonstrator vehicle that proves the viability of the disc-rotor concept.

	FY 2007	FY 2008	FY 2009
Integrated Compact Engine Flow Path	0.000	3.500	4.600

(U) The goal of the Integrated Compact Engine Flow Path program is to develop a structurally integrated, load bearing, composite, thrust vectoring nozzle. Integration of compact inlets and nozzles that are lightweight and survivable continue to be a challenge in military aircraft

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design. Existing metal nozzles are cantilevered off the engine face and the airframe, with an overlap region to allow 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:

FY 2008 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 on a structural element in combined thermal/pressure environments representative of nozzle operating conditions.

FY 2009 Plans:

- Perform design studies for a dynamic loads test nozzle.
- Perform detailed design of a ceramic matrix composite nozzle to be built of high temperature ceramics.

	FY 2007	FY 2008	FY 2009
Active Rotor	0.000	3.380	5.237

(U) The goal of the Active Rotor program is to develop and demonstrate enabling technologies that greatly enhance rotor control and performance, availability, sustainability, and affordability. Performance enhancement objectives are 25-50% improvement in endurance, range, and payload of existing helicopters. Enabling technologies include a dynamically controlled rotor, light-weight high-bandwidth on-blade 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

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the Black Hawk to operate effectively in this environment. The Active Rotor program will focus on development and demonstration of advanced technologies for application to future platforms, with demonstration on a fielded system to facilitate upgrade of current multi-service rotorcraft rotor systems and will demonstrate technologies with broad applicability to military and commercial helicopters.

(U) Program Plans:
FY 2008 Plans:
– Identify and develop advanced lightweight high-bandwidth on-blade actuators, and assess dynamically controlled rotor performance.
FY 2009 Plans:
– Conduct component technology demonstrations and initiate preliminary design of the Active Rotor System.
– Perform sub-scale wind tunnel test of the Active Rotor System.

	FY 2007	FY 2008	FY 2009
Lightweight High Efficiency Aircraft Power Generation	0.000	3.250	5.000

(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 a novel power generation approach that is capable of providing full power (1-2 MW at 25,000 ft/0.8 Mach) within 0.1-2.0 seconds and that can operate in a fuel-efficient standby mode. The power generation system will be tailored for potential 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:
FY 2008 Plans:
– Conduct system trade studies and preliminary design.
FY 2009 Plans:
– Demonstrate power generation components to evaluate output range, responsiveness, and efficiency.

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– Initiate fabrication of demonstrator.

	FY 2007	FY 2008	FY 2009
Nightingale	0.000	0.000	2.000

(U) The Nightingale program will design, develop, integrate and demonstrate the enabling technologies and system capabilities required to perform fully autonomous, just-in-time medical response and evacuation using an autonomous, airborne, man-rated platform. The Nightingale system integrates advanced life support capabilities into a small unmanned (or optionally piloted) air vehicle that can serve as a low cost, high availability air ambulance deployed forward alongside troops in contact. Such a capability offers the opportunity to revolutionize combat casualty care provided by embedded medics and medical teams under adverse and hostile conditions. Nightingale will be capable of unmanned high speed evacuation of casualties to higher echelon, secondary care facilities and may be prepositioned close to combat areas to minimize evacuation timelines. The man-rated Nightingale system will also be capable of autonomous combat search and rescue (CSAR) to eliminate the threat to CSAR crews.

(U) Technical challenges include intelligent, autonomous flight behavior, sensor integrated guidance and control to enable flight in complex terrain, fully autonomous selection and use of suitable landing locations, dual mode (ground and flight) propulsion, collaboration/coordination with human combat medics, and safe and rapid autonomous launch and return to advanced field medical facilities.

(U) Program Plans:
FY 2009 Plans:
– Conduct system trades, effectiveness, and affordability through modeling and simulation.
– Develop sufficient system concept fidelity to validate program goals and objectives.
– Develop Nightingale preliminary design, risk management plan, and technology and system maturation plan.

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	FY 2007	FY 2008	FY 2009
Adaptive Morphing Super-Maneuver Aircraft (AMSMA)	0.000	0.000	3.000

(U) The goal of the Adaptive Morphing Super-Maneuver Aircraft (AMSMA) program, a maturation of the Morphing Aircraft Structure (MAS) program previously funded in PE 0602715E, Project MBT-01, is to demonstrate a technology leap forward to a generation after next aircraft vehicle concept that can provide revolutionary military utility in a number of air vehicle applications and missions. It will build on the demonstrations of the MAS program which established that air vehicles able to seamlessly change configuration in flight are capable of achieving near optimum performance across a range of contradictory missions that would not otherwise be possible with conventional designs. This program will demonstrate an advanced morphing, highly maneuverable air vehicle. Employing a combination of enabling technologies, including asymmetric wing sweep, fore and aft wing translation, and aero-elastic wings with adaptive hinge-less control actuation, AMSMA aims to dispense with traditional flying controls and seeks to achieve efficient aerodynamic and maneuver performance over a wide range of speeds and altitudes. The ability to super-maneuver, employing bird-like flight excursions, offers the warfighter new combat approaches to target prosecution. The concept will introduce a capability whereby one aircraft with the ability to effect multiple radical configuration changes is enabled to conduct a range of missions optimally; this provides the prospect of significant affordability gains through reducing the number of different aircraft types in existing military fleets. The AMSMA program will develop a morphing demonstrator vehicle to expand the flight envelope and to demonstrate revolutionary control and a super-maneuver capability through a series of measurable flight experiments. The anticipated transition partner is the Air Force.

(U) Program Plans:

FY 2009 Plans:

- Identify, develop and demonstrate the critical enabling technologies required to meet the performance goals.
- Design an integrated morphing concept demonstrator vehicle that changes configuration to achieve optimized mission segment performance (e.g. high-speed dash), to achieve maneuver capability including extreme new maneuvers and to optimize tailored survivability.

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	FY 2007	FY 2008	FY 2009
Micro Adaptive Flow Control (MAFC)	4.419	0.000	0.000

(U) Micro Adaptive Flow Control (MAFC) technologies have enabled control of large-scale aerodynamic flows using small-scale actuators. MAFC technologies combined 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 were 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:

FY 2007 Accomplishments:

- Completed sled design and fabrication for High Frequency Excitation for Supersonic Weapons Release (HIFEX) test.
- Completed Mach 2.0 HIFEX system sled test.
- Completed HIFEX system design and fabrication and executed full-scale technology demonstrations.

	FY 2007	FY 2008	FY 2009
Miniature Propulsion Concepts	5.334	0.000	0.000

(U) This program developed concepts for small scale class propulsion systems suitable for Small Unmanned Air Vehicles (UAVs). Small gas turbine engines are typically very inefficient, below 7%, for engines below 10 horsepower. This program developed 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 were developed. These provided a unique Intelligence, Surveillance, and Reconnaissance (ISR) capability for the dismounted soldier.

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(U) Program Plans:
FY 2007 Accomplishments:
- Demonstrated multiple payloads.
- Deployed approximately 100 vehicles with the USMC for in theater testing; logged over 1,600 missions and 1,000 flight hours.
- Transitioned WASP Micro UAV Block III variant to Air Force; it is now a program of record.
- Completed design of subsystems including compliant-foil bearings, alternator and recouperator.

	FY 2007	FY 2008	FY 2009
Peregrine Counter UAV	3.924	0.000	0.000

(U) The Peregrine Counter Unmanned Air Vehicle (UAV) program evaluated low-cost concepts to counter small UAV threats. Peregrine investigated development of a UAV interceptor system capable of providing point cued area defense against small UAV threats using a range of technologies to identify, track, and destroy or otherwise counter multiple threats. Candidate sensor and weapon technologies included acoustic, optical, radio frequency, kinetic, directed energy, and physical envelopment. System technologies included high-assurance integrated command, low-cost persistent unmanned operations, and precise air trajectory control.

(U) Program Plans:
FY 2007 Accomplishments:
- Examined candidate technologies.
- Developed concept design.

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

(U) This program was a joint DARPA/Air Force initiative to design, develop, and demonstrate 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

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under this program may result in the first controllable, recoverable, and reusable hypersonic system demonstration. Initial designs allowed for either a manned or unmanned version, and provided viable options for long-range strike and affordable access to space. The program was divided into two efforts—the High Speed Turbine Engine Demonstration (HiSTED) and the Scramjet Engine Demonstration (SED).

- The HiSTED objectives were to design, fabricate, and ground test a high Mach expendable turbine engine capable of Mach 3-4+ operation. The objective of the ground demonstration was 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.

- The SED effort sought 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 was boosted to Mach 4.5 using a modified ATACMS booster motor. Following separation from the booster, the air vehicle, now designated X-51, accelerated under scramjet propulsion to Mach 6.

(U) Program Plans:

– High Speed Turbine Engine Demonstration (HiSTED)
FY 2007 Accomplishments:
-- Conducted Critical Design Reviews of two engine concepts.
-- Completed high temperature turbine components design and fabrication of one engine concept.
-- Assessed supercritical fuels.
-- Assessed high temperature lubrications and bearings.
-- Performed component integration for one engine concept.

– Scramjet Engine Demonstration (SED)
FY 2007 Accomplishments:
-- Conducted a critical design review for the air vehicle.
-- Conducted freejet testing of the X-1 fuel-cooled scramjet engine.
-- Initiated fabrication of the air vehicles to be used in flight testing.

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	FY 2007	FY 2008	FY 2009
Flare Aero Structures	0.631	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:
FY 2007 Accomplishments:
– Developed aerodynamic models for dynamic lift increments.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Network Centric Enabling Technology TT-13	52.920	72.699	77.588	83.002	75.045	76.531	76.530

(U) Mission Description:

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

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

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(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Networked Embedded Systems Technology (NEST)	4.000	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:

FY 2007 Accomplishments:

- Developed tools for the automatic composition and verification of application-specific coordination service packages; demonstrated the utility of these tools in a fully integrated system consisting of a large network of heterogeneous sensors.
- Developed tools for remotely reprogramming large scale sensor networks and services for authentication and data encryption in those networks.
- Developed and populated a repository of customizable/adaptable services for real-time coordination and synthesis that support military applications.

FY 2008 Plans:

- Develop prototype pulsing and sensing system to measure phenomenology, insertion losses, and radiation efficiency.

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FY 2009 Plans:
- 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 2007	FY 2008	FY 2009
Combat Zones That See (CZTS)	5.000	7.000	6.000

(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:

FY 2007 Accomplishments:
- Developed, installed overseas, and evaluated a force protection prototype that employs approximately thirty cameras.
- Demonstrated sustained tracking of individual vehicles using sensors whose fields-of-view do not overlap.
- Used vehicle track data to calibrate cameras, learn patterns of activity, and retrieve similar or related events from a track database.

FY 2008 Plans:
- Employ motion-pattern analysis to assist in finding common elements among collected tracks.
- Develop methodologies for the efficient and timely management of the video network.

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- 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.

FY 2009 Plans:

- 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 2007	FY 2008	FY 2009
Automated Battle Management	13.400	20.418	20.328

(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.

(U) The Collaborative Networked Autonomous Vehicles (CNAV) program will be the primary demonstration of Automated Battle Management Techniques. It will develop 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 will utilize these capabilities to provide 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

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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.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed secure, robust underwater wireless communications and networking.
- Conducted live demonstration with thirty-eight underwater vehicles collaborating.

FY 2008 Plans:

- 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.

FY 2009 Plans:

- Demonstrate collaborative automated target detection, classification, localization and tracking.

	FY 2007	FY 2008	FY 2009
Home Field	12.369	15.000	13.000

(U) The Home Field program develops networked video and Laser Detection and Ranging (LADAR) processing technology to rapidly and reliably update a 3-Dimensional (3-D) model of an urban area. It provides 3-D 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.

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(U) Drawing upon technologies developed in the Home Field program, the Urban Photonic Sandtable Display (UPSD) program develops revolutionary interactive holographic displays for complex volumetric 3-D data to replace current 3-D visualization technologies that are either static or have limited effective field-of-view. Current technologies include traditional holography, computer graphics on 2-Dimensional (2-D) screens, slice stacking, parallax autostero, and goggles/glasses. These techniques not only give a poor image quality and poor movement, they also are not created quickly and do not allow for collaborative viewer interaction. The desire to improve these components has launched the development of the UPSD. A monochrome active hogel-based proof-of-concept display and further developed module have been validated by transforming computer data to optical data, making sophisticated integration possible to optimize image quality. The UPSD program will develop an affordable 3-D display that operates at full video rate, displays RGB color, increases viewing angle, and increases display size. The result will be the world's first full-motion, full aspect 3-D imaging technology system.

(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated a 3-D model method that used distributed video and LADAR cameras in a mixed urban environment.
- 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.
- Fully developed an active hogel module to provide necessary optical and electrical performance.

FY 2008 Plans:

- Demonstrate the ability to extract architectural features, such as windows and doors, from close-in imagery.
- Build and customize the active hogel modules into tiles and align tiles in superstructure for 2-foot by 2-foot and 3-foot by 3-foot systems.

FY 2009 Plans:

- Research advanced technologies for improving the production methods of pixilated emissive displays.
- Demonstrate 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).

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	FY 2007	FY 2008	FY 2009
Adaptive Reflective Middleware Systems (ARMS)	5.860	8.000	4.000

(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-1000 Future Surface Combatant Family of Ships; however, the technology is applicable to other network-centric DoD systems. Autonomous computing systems require middleware and frameworks that adapt robustly to changes in environmental conditions. The ARMS environment dynamically executes all tasks and mission applications optimized at the platform level, rather than the subsystem level, coordinating the exchange of information predictably, scalably, dependably, and securely among shipboard entities. The ARMS program is developing automated certification technology that will deliver assured deployment of these dynamically managed military computing systems.

(U) Program Plans:

FY 2007 Accomplishments:

- Defined prototype reflective techniques for synthesizing optimized distributed, real-time, and embedded middleware.
- Developed required information models, algorithms, and technologies; developed technologies to configure customizable, standards-compliant middleware and applications.
- Developed robust adaptive protocols, algorithms, patterns, and technologies that exploit standards-compliant middleware.
- Developed and captured design expertise in information models.
- Formalized the successful techniques and constraints associated with building, generating, and validating middleware frameworks and protocol/service components for the DDG-1000 baselines.
- Demonstrated mature, standards-based middleware technologies for transition to the DDG-1000 Surface Combatant Family of Ships.

FY 2008 Plans:

- Develop simulation and analysis component that generates thousands of plausibly certifiable system configurations, performs failure and timing analysis functions, and uses metrics such as co-failure probability to evaluate and rank configurations.
- Develop an automated testing component that creates and deploys tests across a distributed testbed of computers, produces a subset of certifiable configurations, and learns associations between configurations to operational conditions.
- Develop interface for certification authorities to review performance metrics across certified configurations.

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– Evaluate ability to automatically identify certifiable configurations in a representative subset of possible states within a dynamically managed computing environment.

FY 2009 Plans:

– Develop shipboard operational selector component that chooses and deploys the best certified configuration at runtime.
– Evaluate ability to automatically identify certifiable configurations in full DDG-size scenarios using emulated applications.
– Define requirements for integration of automated certification technology with existing standards and processes.

	FY 2007	FY 2008	FY 2009
Integrated Crisis Early Warning System (ICEWS)	5.747	11.000	13.608

(U) The Integrated Crisis Early Warning System (ICEWS) program develops and integrates a set of data analysis tools into a unified information system to support Theater Security Cooperation. The ICEWS system monitors, assesses and forecasts leading indicators of events that make countries vulnerable to 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:

FY 2007 Accomplishments:

– Obtained and organized a large corpus of data describing a representative set of countries and regions in the Pacific Command (PACOM) that are expected to range from stable to highly unstable social dynamics.

FY 2008 Plans:

– Augment existing social science models with emerging computational social science models and theories.
– 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.

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FY 2009 Plans:
- Link Theater Security Cooperation (TSC) resources to factors driving country and regional instability to assess mitigation options.
- Conduct regular experiments to assess predictions in an operational environment.
- Develop tools that can be transitioned to the staff at Combatant Commands (PACOM HQ).
- Create a rigorous analytic capability to predict how alternative courses of actions (COAs) are likely to alter adverse emergent patterns of behavior in order to determine ways more beneficial to U.S. interests.
- Create realistic human leadership models for use in policy analysis, military combat models, and other venues.

	FY 2007	FY 2008	FY 2009
Very High Speed Torpedo Defense	0.000	4.156	5.638

(U) The Very High Speed Torpedo Defense program will develop 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:

FY 2008 Plans:
- Validate preliminary sensor and weapon concepts.

FY 2009 Plans:
- 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.

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

(U) The goal of the Visualizing the Info Ops Common Operating Picture (VIOCOP) program is to research methods 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 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:
FY 2008 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.).
- Research human-computer interfaces to visualize and manipulate information operations data.
- Research mechanisms to integrate the tactical picture with the information operations information.

	FY 2007	FY 2008	FY 2009
Laser Guided Bullet	0.000	0.000	5.014

(U) The Laser Guided Bullet program develops and demonstrates a maneuvering bullet that follows a laser beam to an intended target. Technology development includes the design and integration of aero-actuation controls, power sources, and laser sensors into a limited volume ($2cm^3$) projectile to withstand a high acceleration environment. When integrated and tested, this system will make every shooter with any

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50-caliber weapon a precision sniper at greater than 2 KM range. The Laser Guided Bullet technology is planned for transition to the Army by FY 2010. This program transfers from PE 0603764E, project LNW-01 in FY 2009.

(U) Program Plans:
FY 2009 Plans:
- Design sensor guidance system.
- Perform system integration and validation.
- Conduct in-weapon testing.

	FY 2007	FY 2008	FY 2009
Digital Media Exploitation (MEDEX)	0.000	0.000	4.000

(U) The Digital Media Exploitation (MEDEX) program will develop technology to extract intelligence of tactical value from digital media found on computers captured in the field of operations. MEDEX will automatically search content found on computers captured in the field and identify data of high intelligence value. MEDEX will develop multiple exploitation algorithms that can quickly index, search, and analyze all digital file types: text documents, audio files, images, videos, applications, etc. Additionally, MEDEX will develop network analysis algorithms that identify significant connections between information found on multiple computers. The goal of the MEDEX program is to reduce the exploitation time for digital media from months to minutes.

(U) Program Plans:
FY 2009 Plans:
- Develop automated media exploitation algorithms for multiple operating systems and file types.
- Develop integrated exploitation system that produces ranked lists of summarized content found on digital media.
- Demonstrate intelligence extraction by testing digital media with simulated data.

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	FY 2007	FY 2008	FY 2009
Strategic Communication Assessment and Analysis System (SCAAS)	0.000	0.000	3.000

(U) Strategic communications are focused, integrated efforts to understand and engage key audiences in order to create, strengthen, or preserve conditions favorable for the advancement of U.S. government interests, policies, and objectives. This is accomplished through the use of coordinated programs, plans, themes, messages, and products synchronized with the actions of all elements of national power. Effective strategic communication is central to our ability to effectively deter adversaries, reassure allies, dissuade future competitors, and communicate our resolve to defeat enemies should deterrence fail. The Strategic Communication Assessment and Analysis System (SCAAS) program will develop new theories, concepts, tools and systems to formulate and assess sound strategic communication strategies and measure their effectiveness in influencing allies, adversaries, and other constituencies around the world. This capability would have dramatic value to Combatant Commands (COCOMS) as it would enable the influencing of diverse people and organizations abroad towards U.S. National Security interests.

(U) Program Plans:
FY 2009 Plans:
- Develop models to continuously analyze/assess the strategic communications "information environment" from multiple perspectives and levels of analysis, including audience, context transmitters, and time.
- Develop models for mapping influences to perceptions (such as influences of cultural context, cognitive and emotional biases on message reception and interpretation).

	FY 2007	FY 2008	FY 2009
Urban Warfare Robotic Surveillance (URS)	4.000	0.000	0.000

(U) The Urban Warfare Robotic Surveillance System (URS) program developed new mobile sensor systems, carried on both long-endurance ground and short-endurance air platforms, to support warfighter operations in constrained urban environments. URS explored a mix of sensor technologies (normal and infrared video, active optics, radar, acoustic, magnetic, chemical, and RF direction finding). Sensors were tested in environments characterized by complex multi-path propagation, limited lines-of-sight, and frequent obscuration. Platforms and sensor networks

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were designed to operate in urban exterior, underground, and indoor environments. Communications repeaters and routers provided terrestrial connectivity to all platforms and provided autonomous operation if communications are interrupted. A program demonstration also delivered a prototype robotic squad for testing. The URS program also supported the DARPA Urban Challenge.

(U) Program Plans:
FY 2007 Accomplishments:
- Exercised test platforms in a series of increasingly difficult mission/environment combinations.
- Improved sensors or algorithms that limit performance.
- Funded technology development contracts and program planning support for the DARPA Urban Challenge.

	FY 2007	FY 2008	FY 2009
Diagnostic Network Economies	1.104	0.000	0.000

(U) The Diagnostic Network Economies program improved 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 substantially reduced the risk

(U) associated with network-centric operations, and at the same time assures 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:
FY 2007 Accomplishments:
- Identified the minimum necessary cryptographic machinery to perform adversary detection using secure packet sampling.
- Derived bounds on accuracy of stealthy adversary detection and localization.
- Prototyped a “stealth probing” system.

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

(U) Selected and continued to fund initiatives for the next generation of intelligent communications.

(U) Other Program Funding Summary Cost:

- Not Applicable.