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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, R-1 # 16					
COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	247.405	327.825	361.562	418.818	455.831	483.565	494.565	499.565
Naval Warfare Technology TT-03	41.666	52.313	47.871	52.944	54.943	55.190	60.190	60.190
Advanced Land Systems Technology TT-04	41.269	69.997	77.191	82.249	102.552	124.609	129.109	129.109
Advanced Tactical Technology TT-06	96.031	101.387	95.849	118.502	125.074	125.256	125.256	125.256
Aeronautics Technology TT-07	26.509	49.660	78.290	94.808	95.343	95.252	95.752	95.752
Advanced Logistics Technology TT-10	18.203	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Network Centric Enabling Technology TT-13	23.727	54.468	62.361	70.315	77.919	83.258	84.258	89.258

(U) Mission Description:

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

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

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(U) The Advanced Land Systems Technology project is developing technologies for enhancing the U.S. military's effectiveness and survivability in operations ranging from operations against traditional threats and emerging irregular threats that can employ disruptive or catastrophic capabilities. Networking Extreme Environments will address integration of ultra wide band communications and sensor systems. The Novel Sensors for Force Protection program is developing technologies to protect U.S. warfighters such as an imaging array system that can identify the presence of people inside of buildings and technology capable of stand-off detection of explosive compounds. The Dynamic Optical Tags program will develop new tagging, tracking and location capabilities for U.S. forces. The Guided Projectiles program will develop highly maneuverable gun-launched projectiles for defense against ground and air threats. The Compact Military Engines program will apply innovative ideas for engine design to produce performance gains not obtainable by further refinement of conventional designs.

(U) The Advanced Tactical Technology project is exploring the application of compact and solid state lasers; high performance computational algorithms to enhance performance of radars, sensors, communications, electronic warfare, and target recognition and tracking systems; 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.

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(U) Program Change Summary: *(In Millions)*

	FY 2004	FY 2005	FY2006	FY2007
Previous President's Budget	247.405	339.175	354.525	351.751
Current Budget	247.405	327.825	361.562	418.818
Total Adjustment	0.000	-11.350	7.037	67.067
Congressional program reductions	0.000	-23.200		
Congressional increases	0.000	11.850		
Reprogrammings	0.000	0.000		
SBIR/STTR transfer	0.000	0.000		

(U) Change Summary Explanation:

FY 2005	Decrease reflects congressional program reductions to Novel Sensors, Laser Star, Combat Zones that See, and undistributed reductions offset by congressional adds for National Cyber Security Center, Tactical Awareness for Friend or Foe, CEROS and NASEC.
FY 2006 - 2007	Increase reflects additional funding in the TT-07 project for the Reusable Hypersonics, Walrus, and UAV programs and expansion of naval warfare programs in the TT-03 project.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Naval Warfare Technology TT-03	41.666	52.313	47.871	52.944	54.943	55.190	60.190	60.190

(U) Mission Description:

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

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Friction Drag Reduction	3.605	9.250	13.009	16.899

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

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(U) This program also examined the potential of Lorentz Force Turbulence Control (LFTC), an approach to reduce hydrodynamic drag by the generation of electromagnetic forces. Laboratory tests have demonstrated effective underwater drag reduction, but the energy requirements are very high.

(U) Program Plans:

- Analysis of LFTC data and final report completed.
- Developed a multi-scale modeling capability that will incorporate the physics learned at small scales into large-scale engineering codes for use as reliably predictive design tools.
- Finalized buoyancy test vehicle modeling design and efficiency.
- Developed a preliminary test plan for full-scale buoyancy test vehicle experiment.
- Conducted a full-scale buoyancy test vehicle experiment to provide high-quality data at large scales in order to validate the models.
- Develop an air cavity design tool that calculates a hull form for specified pressure distributions.
- Perform modeling trade-off analysis to determine optimal hull forms supporting air cavity formation at design speed.
- Conduct tests to determine drag reduction achieved.
- Study physics-based hydrodynamic codes to accurately represent the critical features needed to predict design parameters for small craft.

	FY 2004	FY 2005	FY 2006	FY 2007
Surface Warfare Automated Shiphandling (SWASH)	0.000	5.400	4.914	7.822

(U) The Surface Warfare Automated Shiphandling (SWASH) program will develop and demonstrate technologies to increase survivability and operational effectiveness of small and medium naval surface vessels in rough seas. Currently, vessels are at the mercy of ocean waves, and when waves become sufficiently large, damage and capsizing can occur. SWASH will enable safe operations in an expanded sea state envelope. SWASH combines detailed sensing and wave prediction of the local sea surface with improved understanding of vessel dynamics in a control system that provides optimum course and speed to the vessel's rudder and engines. SWASH offers the potential to reduce injuries to crew and passengers as well as damage to vessels caused by high waves. In addition, SWASH is an enabling technology for unmanned surface vessels (USVs), which will be a component of the modules for the Navy's new Littoral Combat Ships (LCS). SWASH will increase the survivability and

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operability of USVs in rough seas, and can provide inputs to the LCS steering system to make USV launch and recovery faster and safer. Medium manned vessels, such as LCS, DD(X), and current classes, will benefit from the more detailed knowledge of wave fields that will be developed in the SWASH program. Sophisticated steering strategies can reduce damage to the vessels caused by high waves, and improve human performance by reducing vessel motions.

(U) Program Plans:

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

	FY 2004	FY 2005	FY 2006	FY 2007
Hypersonics Flight Demonstration (HyFly)	22.099	19.615	11.882	3.078

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

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(U) Program Plans:

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

	FY 2004	FY 2005	FY 2006	FY 2007
High Efficiency Distributed Lighting (HEDLight)	5.988	6.200	2.354	0.000

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
Center of Excellence for Research in Ocean Sciences (CEROS)	7.000	7.000	0.000	0.000

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

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Acoustic Arrays for Torpedo Defense (formerly Electric Curtain)	2.974	4.848	3.760	2.000

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

(U) Program Plans:
- Conduct non-linear pressure pulse propagation modeling and assess projected system performance.
- Design, develop and test transducer module.
- Incorporate ship wake effects into the pressure pulse propagation model.
- Design, develop, and test ¼-scale transducer array.
- Conduct ¼ scale system testing.

	FY 2004	FY 2005	FY 2006	FY 2007
Ribbon Fin Propulsion	0.000	0.000	3.034	6.683

(U) The Ribbon Fin Propulsion program will develop a novel underwater propulsion technology for Unmanned Underwater Vehicles (UUV) and other underwater platforms that require high maneuverability at low velocities. It is believed that electric eels using ribbon fin propulsion may be generating traveling chains of ring vortices, which give more momentum transfer than simply pushing the same quantity of fluid with no structure. The objective of the program is to develop a Ribbon Fin propulsion system and demonstrate the increased low velocity power efficiency and maneuverability of an actual underwater platform. The fundamental technical challenges include 1) determining if the traveling wave is structured to maximize thrust, 2) determining the structure of the fluid flow imparted by the ribbon fin, 3) determining how to implement a flexible

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ribbon structure with sufficient power and controllability to be useful, and 4) how to attach such a structure to a rigid body and integrate it with other control surfaces to gain additional degrees of freedom.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Riverine Crawler Underwater Vehicle	0.000	0.000	3.420	5.261

(U) The Riverine Crawler Underwater Vehicle program will study means of operating in challenging conditions of obstructions, turbidity and current such as in rivers and harbors. Novel means of navigation, propulsion and sensing will be required to operate autonomously in such environments. Port security is a key area of worldwide concern, especially when one considers the tremendous volume of goods that traverse through major ports located around the world. Monitoring traffic flow and obtaining vessel identification information, as well as information on shore activities, would be of considerable value.

(U) A little-explored means of operating in a riverine environment is by an unmanned submerged craft. The scope of this program will be to explore the potential concepts and the technologies to perform these missions. The effort will identify the promising vehicle types and examine the system and/or component element technologies required to support these vehicles.

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Small Craft Advanced Hydrodynamic Design	0.000	0.000	5.498	11.201

(U) Based upon the results of the Friction Drag Reduction program (budgeted in this PE/Project) and other DARPA efforts, the Small Craft Advanced Hydrodynamic Design effort will develop a new capability in predicting small boat hydrodynamics, including small scale phenomena in highly dynamic sea-states, for boats used for high speed patrol, area defense or personnel insertion. The objective of the effort is to demonstrate the capability to produce a physics-based small craft design with prescribed performance parameters. Improved design capability for small craft is critical for the development of stealthy high-speed special warfare craft and for improving the physical impact on crew members during high speed operations.

(U) Program Plans:

- Complete physics-based hydrodynamic codes to accurately represent the critical features needed to predict design parameters for small craft.
- Conduct performance prediction in dynamic environments such as high waves and currents.
- Develop and build a prototype small craft design that exhibits the desired parameters.
- Demonstrate at-sea performance in variable sea conditions.

(U) Other Program Funding Summary Cost:

Hypersonics Flight Demonstration	FY 2004	FY 2005	FY 2006	FY 2007
PE 0602114N, PE 0603114N, PE 0603123N, Navy, Office of Naval Research	20.000	15.000	11.300	2.200

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Land Systems Technology TT-04	41.269	69.997	77.191	82.249	102.552	124.609	129.109	129.109

(U) Mission Description:

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

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Novel Sensors for Force Protection	9.919	10.910	13.459	18.352

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

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

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

(U) The Urban Vision Project will develop the technology and systems to provide the warfighter with an advanced in-depth view of the distribution and location of dielectric bodies that resemble those of enemy dismounted troops or combatants within a building in an urban area. Each node of the array carries a suite of low-power transmitters and receivers that act in concert with real-time electromagnetic analysis codes to "peel back" the structure of the building and the disposition of signatures that are indicative of enemy dismounted troops or combatants within.

(U) The Explosives Detection Project seeks to develop technologies capable of standoff (non-contact) detection of explosive compounds. Of particular importance are high throughput applications, such as military checkpoints, where an extremely low false alarm rate is required. Rather than promoting a single, particular technology, this program will develop a systematic framework of understanding for both the target and background signals. With such an understanding, concepts such as sensor fusion and the optimum setting of thresholds can be properly optimized. In this manner, a system of sensors can be developed that has reliable detection capabilities in both laboratory and field environments. This capability will greatly reduce the threat of suicide bombing, Improvised Explosive Devices (IEDs), and similar tactics faced by troops in the field.

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(U) Program Plans:

- Unique Signature Detection.
  - -- Identify the chemical make-up of the Major Histocompatibility Complex (MHC)-determined unique signatures.
  - -- Examine the chemistry and impact of non-genetic background signals.
  - -- Design detectors that are capable of identifying high-level-of-interest individuals within groups of enemy troops or combatants through unique, specific signatures with high reliability.
- Enemy Dismount Intrusion Detection.
  - -- Determine the required performance of a chemical emission sensor as part of a system of sensors in a perimeter defense.
  - -- Determine the chemical emissions that are unique to humans and therefore to all enemy dismounted troops and combatants.
  - -- Determine the specificity of the human chemosignal in a variety of complex backgrounds.
  - -- Design detectors capable of reliably indicating the presence of enemy dismounted troops and combatants with a low false alarm rate.
- Urban Vision.
  - -- Design, develop, and evaluate an initial (fixed placement) multi-static multi-frequency dielectric imaging array test system.
  - -- Establish baseline system performance parameters for spatial resolution and dielectric differentiation.
  - -- Develop algorithms for inverting the multi-static imaging data to reveal the interior structure and distribution of objects within the structure, and the coarse categorization of those objects with sizes typically associated with enemy troops or combatants and dielectric characteristics.
  - -- Design, develop, and demonstrate Unmanned Aerial Vehicles (UAV) array multi-static dielectric tomography imaging system.
- Explosives Detection.
  - -- Examine current and emerging technology.
  - -- Develop an understanding of background conditions in varying environments.
  - -- Design detectors capable of reliable, low false alarm, stand-off explosives detection.

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	FY 2004	FY 2005	FY 2006	FY 2007
Dynamic Optical Tags (DOTS)	5.947	8.819	9.905	7.794

(U) Based on the technical successes and demonstrated operational relevance of DARPA's now completed Optical Tags program, the Dynamic Optical Tags program seeks to create new tagging, tracking, and location capabilities for U.S. Forces. This program will develop optical tagging and interrogation technologies that will enable small environmentally robust, retro reflector-based tags that can be read by both handheld and airborne sensors at significant ranges. These tags can be used for unique, non-radio frequency (RF) identification of items of interest or monitoring tactical areas for disturbance from personnel and vehicles. The identification tags also will be capable of providing persistent two-way communications for both tactical and logistics operations.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Guided Projectiles	10.909	16.477	20.572	17.547

(U) The Guided Projectiles program is developing and demonstrating highly maneuverable gun-launched projectiles, and associated launch system, and fire control, for point defense against highly maneuverable targets, such as anti-ship cruise missiles, ground-to-air and ground-to-ground threats. This program will also develop enabling technologies to give U.S. warfighters the ability to allow weapons platforms, such as mortars, to receive updated target information from other munitions or sense target changes on their own. Based upon this information, the platforms can adjust course in flight to prosecute highly-mobile, time-sensitive targets such as those encountered during Operation Enduring Freedom and reduce the potential for collateral damage. This program will adapt recent advances in communications, computers, ad-hoc

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networking, sensing and propellants/explosives to demonstrate significant leaps in combat capability. These technologies will demonstrate the increased combat effectiveness and the reliability of distributed, collaborative processing and mission execution.

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

(U) The program will also develop small aperture, geolocation capability for a new-class of anti-radiation weaponry. This program will enable a suite of weapons that home on RF energy emitted by enemy forces to include ground-to-ground, air-to-ground, and ground-to-air weapons all using similar RF sensor guidance technology. The result of this effort will create a passive, all-weather, and inexpensive precision targeting capability for precision and area suppression weapons and counter enemy signals camouflage, concealment and detection efforts. The initial effort will focus on providing an RF homing guidance and warhead package that is capable of being fired out of an 81mm mortar.

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

(U) Program Plans:

- Develop, model and validate supersonic flight control technologies.
- Conduct preliminary development and evaluation of key subsystem technologies.
- Perform initial flight demonstrations and target acquisition demonstrations.
- Fabricate and test critical subsystems for projectile maneuvering, guidance and data transmission.
- Conduct detailed design and feasibility tests of key fire control, lethality, flight control and launch components.
- Develop mortar seeker using an array of non-imaging optical lenses.
- Develop small and responsive mortar guidance/control/steering fin system.
- Integrate seeker with guidance/control/steering system into a unit that replaces the current fuse on the 60mm mortar high explosive round.

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- Develop designator systems that provide visible and infrared light emissions from a target compatible with the optical/guidance unit.
- Demonstrate tube launch of 60mm optically guided mortar round and optical designating system in conjunction with USMC.
- Develop small, moving aperture geolocation techniques, such as tomographic geolocation.
- Investigate techniques for the reduction of channel mismatch errors, such as spinning the mortar to remove bias errors.
- Research multipath mitigation and multiple user discrimination techniques, such as subspace tracking techniques.
- Develop mortar-sized electronics and guidance package.
- Demonstrate tube launch of 81mm RF guided mortar round and field realizable cueing system in conjunction with transition partner.
- Initial design of mortar mounted RF seeker and mortar control system.

	FY 2004	FY 2005	FY 2006	FY 2007
Networking Extreme Environments (NetEx)	5.858	8.425	4.978	3.958

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

(U) Program Plans:

- Characterized the effect of UWB system operation on military radio frequency receivers.
- Determined the thresholds of interference of UWB, which are caused by legacy equipment and methods by which it can be reduced.
- Develop an improved UWB physical layer.
- Develop a Tactical Voice/Data Radio (TVDR) with ranging.
- Develop a Low Bit Rate Sensor Network with highly accurate geolocation.

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- Develop ad-hoc networking and multiple access protocols to take advantage of the unique properties of UWB.
- Integrate UWB communications and sensors systems into an interoperating net.
- Conduct experiments on the integration of UWB into an operating network.

	FY 2004	FY 2005	FY 2006	FY 2007
Stimulated Isomer Energy Release (SIER)	3.000	4.000	0.000	0.000

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

(U) Program Plans:

- Determine if the hafnium isomer can be triggered with photons in the x-ray range that will release more than 50 times the energy input of the trigger.
- Identify a hafnium isomer production process that is affordable and cost effective.
- Develop a physics approach to a chain reaction for the hafnium isomer.

	FY 2004	FY 2005	FY 2006	FY 2007
MAgneto Hydrodynamic Explosive Munition (MAHEM)	0.000	4.200	4.880	4.765

(U) The MAgnetoHydrodynamic Explosive Munition (MAHEM) program will demonstrate compressed magnetic flux generator (CMFG)-driven magnetohydrodynamically formed metal jets and self forging penetrators with significantly improved performance over explosively formed jets and fragments. Explosively formed jets (EFJ) and self forging penetrators (SFP) are used for precision strike against targets such as armored vehicles and reinforced structures. Current technology uses chemical explosive energy to form the jets and fragments. This is highly inefficient and requires precise machining of the metal liners from which the fragments and jets are formed. Generating multiple jets or fragments from a single explosive is difficult, and the timing of the multiple jets or fragments cannot be controlled. MAHEM offers the potential for higher

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efficiency, greater control, the ability to generate and accurately time multiple jets and fragments from a single charge, and the potential for aimable, multiple warheads with a much higher EFJ velocity, hence increased lethality and kill precision, than conventional EFJ/SFP. MAHEM could be packaged into a missile, projectile or other platform and delivered close to target for final engagement and kill. This could provide the warfighter with a means to address stressing missions such as: lightweight active self-protection for Future Combat Systems (FCS) vehicles (potential defeat mechanism for a kinetic energy round); counter armor (passive, reactive, and active); mine countermeasures; and anti-ship cruise missile final layer of defense.

(U) Program Plans:

- Refine magnetohydrodynamic models of MAHEM behavior.
- Conduct capacitor-driven liner experiments to validate models.
- Complete single and multiple-liner CMFG and MAHEM concept designs.
- Develop and conduct experiment demonstration of CMFG and CMFG-driven MAHEM.
- Develop MOA with transition partners, demonstrating MAHEM variants tailored to their mission-specific requirements.

	FY 2004	FY 2005	FY 2006	FY 2007
Compact Military Engines	2.000	6.066	2.210	1.324

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
Crosshairs	1.636	4.000	6.000	9.500

(U) This program will develop methods and equipment to enable blue-team forces to detect, locate, and engage shooters and defeat Rocket Propelled Grenades (RPGs), Anti-Tank Guided Missiles (ATGMs), etc. in urban environments. Location will be made with sufficient timeliness for effective counteraction and shooter elimination. This will be achieved with minimal exposure of blue-team forces to further attack. A combination of techniques will be used to achieve these goals. Technologies may include acoustic sensors to determine bullet shooter locations and high-speed IR imaging or radar to determine RPG trajectories and backtrack to shooter origin. Automated responses such as imaging for forensic and judicial evidence, rapid dissemination of location of combatants to allow both effective concealment and counterfire, slew to cue weapons, protective measures against RPGs followed by counterfire, and elimination of threats. The Concept of Operations is to provide HUMMWV mounted detection and response systems that operate while on the move and a lightweight portable freestanding low power unit for platoon or squadrons while stationary. Techniques for supporting detection and false-alarm rate mitigation will be considered, including acoustic detection, optical, radar and sniper scope detection. It is envisioned that the system will provide a significantly improved capability to detect and engage snipers during hostile and peacekeeping operations in both urban and non-urban environments. Technology challenges of particular interest are: low false rate algorithms, high speed reactive sensor techniques for a 360 degrees azimuth and 60 degree elevation detection zone; robust data collection for tracking firing source; fast response and affordable solutions. The program will culminate with a series of prototype demonstrations of the system(s) in typical combat environments.

(U) Program Plans:
- Identify and develop ultra-fast sensors and algorithms to detect and track multiple threats in near real time.
- Perform component testing and conduct detection and shooter localization demonstrations.

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- Analyze data and integrate sensors and response system with appropriate vehicle mounted counter-measures.
- Assess utility for dismounts.

	FY 2004	FY 2005	FY 2006	FY 2007
Vertical Infiltration, Persistent Extraction Robot (VIPER)	2.000	5.100	0.000	0.000

(U) This program will apply concepts from the Novel Sensors program to the development of technologies to enable a robotic platform with a small body diameter and three-dimensional mobility. System challenges to the development of a high-degree-of-freedom robot include: power generation, management and storage; locomotion; terrain and situational awareness; navigation and control; health and status monitoring; and position and configuration management. The program will also evaluate design approaches and concepts of operation for implementation and utilization of such a robotic platform.

(U) Program Plans:
- Perform a risk reduction and feasibility demonstration phase of the basic platform.
- Develop the integrated robotic system concept and multiple degree-of-freedom operator control software.
- Complete component testing to characterize system performance.

	FY 2004	FY 2005	FY 2006	FY 2007
Improved Explosives	0.000	0.000	5.398	7.260

(U) Drawing upon work performed in the Guided Projectiles program, the Improved Explosives program seeks to develop more powerful explosives for existing U.S. munitions. Such explosives are envisioned to provide U.S. small infantry units with organic firepower equal to light and medium artillery units. The explosives will provide U.S. forces with dominant capabilities in urban area operations by allowing the projection of superior destructive power against high-value targets. In addition, improved explosives will aid in denying sanctuary to enemy assets, including those hidden in armored, hardened or buried locations, as a result of the development of explosives with better energy transfer. The goal of the program is to develop high explosives systems that deliver three to five times more power (pound-per-pound) than conventional systems that use

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TNT or Composition B. The power of the explosive will be measured in peak pressure and brisance. The intent is to use the improved explosives in small projectiles that are easily moved about the battlefield. Initially, this program will focus on developing a lightweight wall-breaching rocket system that will allow ground troops to quickly deliver, with one shot, an explosive system to make a large hole in walls and buildings so they can enter unexpectedly.

(U) Program Plans:
- Develop shaped charge explosives and associated technologies that will yield high energy transfers, warhead-to-target.
- Develop methods to extend the service life of small diameter anti-tank munitions (e.g., the current M72 LAW and AT4) so that these munitions can be upgraded with improved explosives rather than develop new munitions.
- Develop new high-hydrogen explosives.

	FY 2004	FY 2005	FY 2006	FY 2007
Agile Interceptor	0.000	0.000	8.289	10.249

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

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Counter Improvised Explosives Laboratories (CIEL)	0.000	1.000	1.500	1.500

(U) This program is an outgrowth of the work performed in this project under the Novel Sensors for Force Protection, Explosives Detection Project. Improvised explosives (IEs) are considered one of the most popular methods used by terrorist groups. Over the past 20 years, IEs have become very common due to their easy preparation and the high availability of raw materials. Efficient methods for detecting and neutralizing/desensitizing sensitive explosives labs in an urban environment will minimize interference with troop operations and minimize collateral damages. The goal of the Counter Improvised Explosives Laboratories (CIEL) program is to develop the infrastructure and methodology for novel chemo-sensors that will identify labs that are building IEs to a very high degree of specificity and reliability; and develop the infrastructure for tools for safe handling of improvised explosives and their mixtures.

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

	FY 2004	FY 2005	FY 2006	FY 2007
National Cyber Security Center	0.000	1.000	0.000	0.000

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

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

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(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Tactical Technology TT-06	96.031	101.387	95.849	118.502	125.074	125.256	125.256	125.256

(U) Mission Description:

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

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
High Power Fiber Lasers	11.787	11.270	10.606	9.000

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
High Powered Femto Second Laser Diodes	3.270	3.151	4.000	5.000

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

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Super High Efficiency Diode Sources (SHEDS)	9.916	9.188	4.288	3.000

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

(U) Program Plans:

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

	FY 2004	FY 2005	FY 2006	FY 2007
High Energy Liquid Laser Area Defense System (HELLADS)	11.948	20.841	20.000	20.000

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

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lightweight HEL weapon system. HELLADS will design, fabricate and test a prototype laser. A laboratory demonstration of key performance parameters will be performed, followed by the fabrication and testing of a subscale HEL laser. Once key weapon system parameters have been demonstrated, a full-scale 150 kW HEL weapon system will be fabricated and demonstrated. Finally, the 150 kW HEL will be integrated into a surrogate aircraft and key performance parameters will be demonstrated.

(U) Program Plans:

- Conduct key technology demonstrations of resonator stability, laser gain, and system thermal performance.
- Develop and test a 15 kW sub-scale HEL system.
- Complete detailed design and initiate construction of 150 kW laser weapon system.
- Demonstrate performance of a 150 kW HEL system in a ground test.
- Integrate HEL system into surrogate aircraft.
- Demonstrate performance of a 150 kW HEL system in captive flight test.

	FY 2004	FY 2005	FY 2006	FY 2007
Laser Star	7.677	2.885	2.800	2.000

(U) The Laser Star program will investigate technologies and techniques for improving laser guide star generation for adaptive optics atmospheric compensation of laser propagation. Current technology makes use of either stratospheric Rayleigh backscatter or mesospheric sodium resonance scattering. These techniques have been utilized to successfully demonstrate strategies for wavefront compensation, but suffer from practical restrictions limiting operational utility. Rayleigh guide stars can be effectively generated to altitudes of 15 – 20 km, beyond which decreasing air densities reduce the backscatter to the point where unrealistic laser powers are required for useful return signal. The altitude is insufficient to provide full atmospheric sampling and suffers from sensor/target signal cancellation. Sodium resonance scattering is available to 90 km, which is an essentially complete atmosphere sample, but the return is monochromatic and cannot provide information about turbulence-induced absolute tilt. Laser Star technologies are being developed to overcome these shortfalls.

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(U) Program Plans:
- Complete concept design.
- Develop experiment design and procure long lead items.
- Conduct experiment.
- Analyze data and integrate with atmospheric compensation programs.

	FY 2004	FY 2005	FY 2006	FY 2007
Coherent Communications, Imaging and Targeting	8.872	8.020	6.200	5.725

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

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

(U) The high data-rate optical communications project will exploit the characteristics of CCIT SLMs to dynamically generate orbital angular momentum (OAM) of photons. Using SLMS to change the OAM of photons in real-time as opposed to simply modulating the amplitude of light

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waves allows for significant improvement in data carrying capacity. The program will also develop system level architectures for secure free space optical communication networks.

(U) Program Plans:

- Develop 256 x 256 element spatial light modulators and integrated electronics, with pixel flatness of one fiftieth of a wavelength, 98 percent fill factor, eight bits of phase resolution and ten micro-second response time.
- Concept development of target acquisition and hand-off to SLM arrays.
- Develop concept for unambiguous resolution and detection of OAM states.
- Conduct computer modeling of OAM modification.
- Design laser transmitter and receivers.
- Develop orthogonal code.
- Develop prototype system with high-speed parallel electronics and demonstrate ground to space communication links and aberration-free imaging.

	FY 2004	FY 2005	FY 2006	FY 2007
High Performance Algorithm Development/Virtual Electromagnetic Test Range	13.155	13.409	11.471	17.500

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

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(U) Program Plans:

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Integrated Sensing and Processing	8.697	8.165	5.000	7.000

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

(U) Program Plans:

- Develop and demonstrate new mathematical approaches to adaptive optimal control of tunable, mode-switchable, and configurable sensor systems/networks in which detection, estimation, classification, and tracking requirements determine sensing system operating parameters.
- Investigate extraction of high-level information directly from analog signals as part of the analog-to-digital conversion process, allowing joint optimization of traditionally separate sensing and processing functions.
- Develop real-time waveform design and scheduling strategies for ambiguity reduction and clutter mitigation in pulse diversity radar systems.
- Develop and demonstrate multiplex sensing, feature extraction and three-dimensional imaging capability in passive interferometric sensors.
- Develop and demonstrate spatio-spectral feature extraction and four-dimensional (three spatial, one spectral) reconstructions in passive interferometric sensors.
- Demonstrate feasibility of designs for quadrature thinning of two-dimensional conformal arrays that exhibit the same or better beam patterns than conventional arrays using fewer transmit/receive modules.

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- Develop information-theoretic metrics relating detection, estimation, classification, and tracking requirements to waveform structure in active sensing systems and use these metrics to devise new classes of mathematically optimal waveforms.

	FY 2004	FY 2005	FY 2006	FY 2007
Mission Specific Processing (MSP)	2.589	2.563	0.000	0.000

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

(U) Program Plans:

- Conduct simulation and benchmarking of initial custom design techniques in the context of mission specific signal processing requirements.
- Develop detailed system architecture of wideband adaptive radar/electronic intelligence-/seeker receiver enabled by MSP method.
- Develop a wideband adaptive radar receiver based on MSP custom cell libraries and modules.
- Demonstrate a ten-fold performance improvement in custom radar signal processing chips.
- Complete library of key digital signal processing function kernels and supporting tool augmentations.
- Complete development and demonstration of space-time adaptive processor for seeker-receiver.
- Conducts first pass evaluation of semi -custom, full scale chip in a space-time adaptive receiver testbed.
- Demonstrate full scale ASIC development using MSP architectures and techniques focusing on MSP design methodologies that reduce design time requirements as compared with full custom.

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- Complete a demonstration that addresses system level issues and quantifies the increased performance relative to standard cell ASIC designs.

	FY 2004	FY 2005	FY 2006	FY 2007
Training Superiority	15.736	15.029	15.542	25.717

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

(U) Program Plans:

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Language and Speech Exploitation of Resources Advanced Concept Technology Demo	0.700	0.132	0.132	0.000

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

(U) Program Plans:

- Refined the two-way translator capabilities for testing in military utility assessments (MUAs).
- Developed a translator in Arabic dialect for which substantial annotated speech data was available.
- Integrated component technologies including:
  - -- Speech recognition in English and Arabic.
  - -- Speech playback in Arabic and English.
  - -- Information extraction and translation from Arabic to English.
- Ported translator to a second critical language (e.g., Vietnamese, Thai), for which little annotated speech data is now available.
- Installed translator on small, readily available platforms (e.g., laptops, handhelds).
- Test and evaluate language technology in the service labs.
- Transition the translator technology to the ACTD for MUAs.

	FY 2004	FY 2005	FY 2006	FY 2007
Air Laser	0.000	2.424	3.344	6.270

(U) The Air Laser program will investigate the potential for a high energy laser (HEL) concept based on direct diode pumping of liquid oxygen. If successful, the Air Laser could provide a safe, efficient kilowatt-class HEL which combines the advantages of chemical and solid state

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lasers and minimizes the disadvantages: it operates in the eye-safe wavelength regime; it uses liquid air as the gain medium and as the diode array coolant, resulting in the reduction or elimination of a separate thermal control system; the use of efficient, high energy density diode pump sources, results in a compact device much smaller than either chemical or solid state lasers; and its pulse length is variable from continuous to sub-picosecond, allowing flexibility in weapons effects.

(U) Program Plans:
- Perform system/utility analyses.
- Develop and demonstrate a 4 kW intra-cavity laser design.
- Develop and demonstrate 20 kW laser design.
- Develop 100 kW laser design.
- Develop kilowatt-class red diodes.
- Develop high-power mirror coatings for this wavelength.

	FY 2004	FY 2005	FY 2006	FY 2007
Architecture for Diode High Energy Laser Systems	0.000	0.000	4.000	8.000

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

(U) Program Plans:
- Demonstrate a three-fold improvement in diode array lifetime with a preliminary data set that projects to tenfold improvements in diode lifetime.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Slingatron	0.000	0.000	3.000	4.000

(U) The Slingatron program will use modern engineering and physics concepts to accelerate masses to extremely high velocities. This mechanical mass acceleration concept, based on using centripetal body forces, is fundamentally different from electro-magnetic accelerators and hence avoids the limitations of those machines. Initial studies have demonstrated the fundamental feasibility of the Slingatron concept. This program will explore the concept's bounding limits and seek to develop uses for the technology within those limits. Included in this program will be studies of the key technologies that will allow the accelerator to achieve very high projectile energies.

(U) Program Plans:
- Conduct feasibility analysis and design studies; fabricate experimental launchers.
- Demonstrate mass launchers that range in capabilities over three to four orders of magnitude.
- Demonstrate mass velocities on the order of several km/s and perhaps higher than 10km/s.

	FY 2004	FY 2005	FY 2006	FY 2007
Photonic High Power Microwave System	0.000	0.000	1.000	2.000

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
Rapid Checkpoint Screening	1.481	4.310	4.466	3.290

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
Water Rocket	0.203	0.000	0.000	0.000

(U) The Water Rocket program supported research and development of a robust concept for space power and propulsion supported by water as a replenishable propellant and fuel. Water is an inexpensive and easily handled propellant. A regenerative fuel cell system, enabled by emerging new technologies, was developed and demonstrated. The regenerative fuel cell would: 1) convert water to hydrogen and oxygen for use in thrusters, and 2) generate electricity while converting some of the hydrogen and oxygen back to water, thereby replacing the heavy batteries routinely used in satellites to supply electric power during nighttime. As a result of this program, future spacecraft will be more easily maneuvered, moved into higher orbits, and refueled to accomplish advanced missions.

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(U) Program Plans:

- Performed critical technology demonstrations and analysis of the system for the regenerative fuel cell and other developmental components.
- Designed, fabricated, and tested a brassboard regenerative fuel cell system demonstrating performance and endurance.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Aeronautics Technology TT-07	26.509	49.660	78.290	94.808	95.343	95.252	95.752	95.752

(U) Mission Description:

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

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Micro Adaptive Flow Control (MAFC)	11.422	9.736	4.015	3.300

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

(U) Program Plans:

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

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- Completed SCORPION Phase III technology roadmap.
- Complete sled design and fabrication for High Frequency Excitation for Supersonic Weapons Release (HIFEX) phase III test.
- Complete HIFEX system design and fabrication for HIFEX phase III test.
- Complete SCORPION system design and fabrication for SCORPION phase III test.
- Design and integrate SCORPION full-scale control system.
- Configure and execute Phase III full-scale technology demonstrations.
- Conduct analysis of vortex interactions at a level necessary to achieve useful performance and aircraft control in close proximity.
- Evaluate advanced composite manufacturing techniques for air vehicles and flow control.
- Develop SSMAV system level requirements, control authority, navigation accuracy, and emplacement techniques, particularly for applications in urban environments.
- Conduct detailed simulation studies to determine enhanced range and precision capability with chemical thruster jets.
- Conduct experimental wind tunnel tests with candidate fixed wing/rotary wing micro air vehicle (2 to 5 inches in size).
- Conduct experimental wind tunnel tests with integrated chemical thruster jets to determine control authority improvement and aerodynamic performance, i.e. stall characteristics of vehicles.

	FY 2004	FY 2005	FY 2006	FY 2007
Small Scale Propulsion Systems (SSPS)	9.087	7.864	4.385	4.354

(U) Concepts for a new, small scale class of propulsion systems will be developed in the size range from 0.5 cm to 7.0 cm in diameter, with thrust levels from 10g to 10kg. They will enable future development of a new generation of very small weapons and military platforms including micro air vehicles, unmanned combat air vehicles, missiles and space launch vehicles. Radical new capabilities to be explored range from shirt-button-sized gas turbine and rocket engines to 7 cm scale gas turbine and pulse detonation engines. Engines may be explored at larger scale to prove feasibility. Examples of new mission capabilities may include delivery of very small (200g) satellites to low earth orbit, extended range small-scale precision munitions, and lightweight, long endurance miniature reconnaissance vehicles. These small-scale munitions would complement emerging unmanned vehicle systems and greatly increase mission capabilities by simultaneously increasing loadout, range and precision. In addition, the program will explore the feasibility of using miniature pulse detonation engines (MPDEs) to acoustically and thermally (infrared) emulate vehicle signatures.

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(U) Program Plans:
- Demonstrated the critical components of a liquid-fueled micro-rocket with turbopumps operating with 1.5 kg thrust.
- Achieved diesel fuel operation of a novel crankless internal combustion engine.
- Demonstrated initial operation of a small diesel-fueled turbojet engine with a 20:1 thrust to weight ratio on.
- Demonstrate small, long endurance engine using novel designs for un-cooled ceramic components with power density greater than 2 HP/lb, efficiency greater than 25% and a durability of greater than 500 hours.
- Demonstrate multifunctional structure plus battery for micro air vehicle (MAV) wings that yield three times more duration than with traditional wing structures and conventional batteries.
- Investigate compatibility of optical flow and uncooled IR approaches with multifunctional structures to enhance surveillance capability.
- Transition micro air vehicle to military applications.

	FY 2004	FY 2005	FY 2006	FY 2007
Peregrine / UAV Killer	0.000	1.410	3.200	6.146

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

(U) Program Plans:
- Define system requirements.
- Develop concept design.

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– Demonstrate aircraft performance and kill capability.

	FY 2004	FY 2005	FY 2006	FY 2007
Walrus	6.000	10.000	20.000	30.000

(U) The Walrus program will develop and evaluate a very large airlift vehicle concept that is designed to control lift in all stages of air or ground operations including off-loading of payload without taking onboard ballast other than air. Unlike earlier generation airships, it will generate lift through a combination of aerodynamics, thrust vectoring and gas buoyancy generation and management and for much of the time, it will fly heavier than air. The program will develop an operational vehicle concept and will conduct risk reduction demonstrations on a Walrus Advanced Technology Demonstration (ATD) air vehicle. The ATD vehicle will demonstrate scalable aircraft technology, is anticipated to achieve comparable C-130 airlift capability, and will explore, develop, and demonstrate the system concepts of operation. The Walrus objective vehicle will have a primary mission to deploy composite loads of personnel and equipment (for example, the components of a Unit of Action) ready to fight as they disembark from the aircraft within 6 hours after landing. Walrus will operate without significant infrastructure and from unimproved landing sites, ostensibly flat but over rough ground to tolerate 5 feet high obstacles. It will carry a useful payload >500 tons over global distances (12,000 nm in less than 7 days) at a competitive cost. Additionally, Walrus will be capable of performing theater lift, support of Sea Basing, and persistence missions to meet a range of multi-agency needs. Advanced breakthrough technologies will be investigated in the first phase to support the development of lift and buoyancy concepts. The program's first phase will include system studies and development of a notional concept of the objective vehicle. Based on these studies and concept viability, the competitive second phase will lead to the development of an objective air vehicle design and building and initial flight test of the ATD vehicle. Outyear funding is budgeted in PE 0603286E, Project AIR-01 to continue the program past Phase I.

(U) Program Plans:
- Define and develop a notional objective air vehicle concept having a payload capability circa 500 tons.
- Establish the feasibility of breakthrough technologies.
- Develop air vehicle design concepts that will validate the objective air vehicle concept.
- Perform conceptual design and trade studies of air vehicle variants for a variety of mission roles, including study of technology risk reduction, architecture, survivability, and vehicle conservation.

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	FY 2004	FY 2005	FY 2006	FY 2007
High Speed / Hypersonic Reusable Demonstration	0.000	15.000	30.000	20.700

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

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

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

(U) Program Plans:

- HiSTED
  - Complete high temperature turbine components design and fabrication.
  - Assess supercritical fuels.
  - Assess high temperature lubrications and bearings.

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- Perform component integration.
- Conduct integrated engine ground testing.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Helicopter Quieting (formerly Helicopter Rotor Blade Quieting)	0.000	5.650	6.290	8.552

(U) Studies and performance results from current U.S. military operational systems, as well as other DARPA programs in this project, have shown that it is vital to increase the survivability and lethality of U.S. helicopters by reducing their acoustic signature, thereby making them more difficult to detect, track and engage. The Helicopter Quieting Program is developing revolutionary new rotor blade design tools that will enable the creation of novel rotor blades that can dramatically reduce the acoustic signature of a helicopter without sacrificing flight performance. Current rotor blade development approaches rely on an iterative cycle of analysis and model wind tunnel tests (time consuming and costly) or go straight from analysis to full-scale wind tunnel/flight test (high risk and costly). Because of the significant issues of time, cost, and risk, helicopter rotor designers cannot explore the revolutionary potential of emerging new rotor noise-reducing technologies in the design process. Recent advances in computational fluid dynamics (CFD) will be leveraged to develop physics-based predictive design tools that will allow designers to develop revolutionary rotor blade designs with vastly improved acoustic characteristics. The predictive tools will be tested using existing data sets and data collected from fully instrumented full-scale and model-scale experiments. The tools will then be used to design new blades that yield a significant reduction in low-frequency in-plane signatures without impacting performance compared to a baseline design.

(U) Program Plans:
- Develop predictive blade design tools.
- Validate models using experimental data.

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– Use the tools to design new blades that yield a significant reduction in low-frequency, in-plane signature.

	FY 2004	FY 2005	FY 2006	FY 2007
Nano-Flapping Air Vehicles	0.000	0.000	2.300	6.956

(U) The goal of this program is to develop flapping air vehicle technology that results in a bio-inspired flapping air vehicle with less than 2 inch wingspan and gross takeoff weight of approximately 10 grams or less. Operations in the urban terrain require sensors that can navigate in difficult terrain and to 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 technology include, flapping wing aerodynamics, kinematics and flight dynamics, lightweight aeroelastically tailored wing structures, miniature navigation systems, micro-propulsion systems and small payloads. This effort will also examine novel materials that can be used to develop integrated wing structures, which change composition to achieve multiple expressions. This would make possible the use of vehicles, which could be camouflaged, or blend into the surrounding landscape, enabling in theater disposal and preventing mission detection/compromise.

(U) Program Plans:

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

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	FY 2004	FY 2005	FY 2006	FY 2007
Flare Aero Structures	0.000	0.000	2.100	5.800

(U) The Flare Aero Structures program will explore and develop a new approach to take off and landing of fixed wing aircraft. The landing field requirement for fixed wing aircraft limit their use in both confined (e.g. urban) and remote unprepared areas. This program will explore unsteady aerodynamics during rapid pitch up or flare landing maneuvers. It is known that very high lift coefficients can be obtained for a short period of time during such a maneuver. The technical challenge is to develop the aero structures, control effectors and control logic that will allow for a practical application of this phenomenon to fixed wing aircraft to allow landing in a very short distance. This could lead to small/medium UAVs such as the FCS Class III that can land on unprepared areas without the need for an arresting system. Additionally, an application of this technology for paratroops will be evaluated.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Macaw	0.000	0.000	6.000	9.000

(U) This program is an outgrowth of the Small Scale Propulsion Systems (SSPS) program. The goal of the Macaw program is to develop a helicopter emulator carried on a small UAV. The system would use miniature pulse detonation engine (MPDE) technology to provide acoustic and thermal (infrared) emulation of a variety of helicopters. Macaw could be used for mine clearing/route determination as well as escort missions. The system would draw fire from ground based adversaries, determine their location, and relay the information back to the operator. The Macaw system would protect Army and SOCOM helicopters from ground fire, small arms, rocket-propelled grenades (RPGs), man-portable air defense systems (MANPADS), and anti-helicopter mines.

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

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Network Centric Enabling Technology TT-13	23.727	54.468	62.361	70.315	77.919	83.258	84.258	89.258

(U) Mission Description:

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

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

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(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Network Embedded Systems Technology	11.318	11.255	7.000	4.000

(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 sensor networks consisting of elementary nodes 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 a few tens of simple computing nodes arrayed in a network in an ad hoc manner to several tens of thousands of nodes. NEST produces reusable software libraries and design tools that simplify the design task for those applications.

(U) Program Plans:

- Design deterministic and probabilistic methods for self-stabilizing protocols for lightweight coordination services, such as global clock synchronization and/or sensor localization.
- Develop design tools for the customization of coordination-services to specific applications based on requirements and platform characteristics.
- Develop formal modeling and verification techniques for coordination and integration.
- Conduct field experiments and demonstrations of NEST technology in a variety of sensor network monitoring and tracking applications of relevance to the Special Forces, the Marines and the Army.
- Demonstrate real-time synthesis of schedules (e.g., actuator firing sequences) and services (e.g., localization, route planning) using phase transition-aware constraint solvers.
- Develop tools for the automatic composition and verification of application-specific coordination service packages; demonstrate the utility of these tools in a fully integrated system consisting of a large network of heterogeneous sensors.
- Develop tools for remotely reprogramming large scale sensor networks and services for authentication and data encryption in those networks.

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	FY 2004	FY 2005	FY 2006	FY 2007
Combat Zones That See (CZTS)	0.000	4.213	7.436	8.875

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

(U) Program Plans:

- Develop, install and evaluate a force protection prototype, on an overseas military base, that employs approximately 30 cameras.
- Demonstrate sustained tracking of individual vehicles using sensors whose fields-of-view do not overlap.
- Use vehicle track data to calibrate cameras, learn patterns of activity, and retrieve similar or related events from a track database.
- Employ motion-pattern analysis to assist in finding common elements among collected tracks.
- Develop techniques to optimize the location and orientation for emplacing cameras.
- Develop methodologies for the efficient and timely management of the video network.
- Develop, install, and evaluate a MOUT-configured prototype using approximately 100 rapidly deployed cameras.

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	FY 2004	FY 2005	FY 2006	FY 2007
Automated Battle Management	6.332	14.800	13.723	15.459

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

- The Mission Driven Control of Autonomous Robotic Systems (MDCARS) program will develop autonomous control methods to cause distributed platforms to self-organize and distribute tasks through judicious transactions conveyed over a shared communications network. Techniques to permit rapid insertion of new functional elements (such as, new platforms, sensors, control stations, visualization tools, algorithms, and databases) into robotic system networks will be explored. MDCARS supports explicit publication of data models and control strategies used by sensors, algorithms, tools, and databases and references appropriate knowledge bases to define transformations between different data models. Products will be integrated via semi-automatic tools to accelerate system and information integration. This effort permits rapid adaptation of robotic systems behavior to changes in the real-time military situation. The program accelerates configuration and integration of robotic systems at field sites, enabling rapid technical upgrade, improving interaction with coalition partners and system tailoring to new environments. Finally, this effort allows complex robotic systems to be rapidly assembled from discrete pretested components and tailored robotic systems to be assembled for particular tasks.

- The Organic Sensor Exploitation Network (OSEN) program will develop rapid, highly autonomous techniques for sensor exploitation by leveraging technology from the NEST program to support autonomous sensor networks in ground warfare. The goal of OSEN is to provide network-enabling technology for processes currently performed at centralized ground stations and analysis centers. The objective is to move processing closer to the sensor to reduce the need for expensive communications back to a central site and provide robustness to unexpected loss of platforms, communications disruptions, and unpredictable target behavior. OSEN is developing technology to: (1) permit on-board exploitation of sensor data from remotely deployed sensor nodes; (2) support correlation of information developed across

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different platforms; (3) detect, track, and identify targets in the field-of-view of a platform; (4) cue other sensors to acquire a target; and (5) transition targets to other platforms as different targets move through sensor fields-of-view. OSEN system studies will evaluate the relative value of different sensor mixes against low-flying aircraft, ground vehicles, dismounted infantry, and irregular forces. Sensor candidates include: electro-optical, infrared, radar, passive RF, acoustic, seismic, and magnetics which may be fixed or mounted on mobile platforms. The program accommodates variable communications connectivity; models predict changes caused by line-of-sight occlusions.

(U) Program Plans:

– Mission Driven Control of Autonomous Robotic Systems.
  -- Interact with visionary military experts; identify combined arms scenarios where highly robotic systems offer tactical advantages.
  -- Construct a simulation-based testbed to mimic the kinematics, sensors, and logistics of a representative robotic force.
  -- Procure a set of distributed control technologies, based on distinct technical approaches.
  -- Implement each technology as a closed-loop controller attached to the simulation-based testbed.
  -- Implement testbed results and downselect to the two best approaches.
  -- Establish a hardware-in-the-loop test facility at a secure military installation, including robotic platforms and communications nets.
  -- Select the most advanced control technologies in terms of speed, flexibility, and robustness.
  -- Implement quarterly exercises of the control schemes in the test facility.
  -- Coordinate with transition partner(s) final demonstrations as part in a series of Service exercises.

– Organic Sensor Exploitation Networks (OSEN).
  -- Define representative sensor mixes and operational scenarios.
  -- Perform analytical trade studies to generate representative sensor network components and tactics.
  -- Develop a network node architecture adaptable to the devices present at that node.
  -- Prototype candidate algorithms for each function (search, detect, track, identify, correlation, hand off) based on alternative technologies.
  -- Evaluate candidate algorithms in a synthetic environment to calibrate and verify performance models.
  -- Insert selected algorithms into a hardware-in-the-loop testbed; demonstrate practical utility and verify system performance.

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	FY 2004	FY 2005	FY 2006	FY 2007
Eyes-On System	1.132	5.350	0.000	0.000

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

(U) Program Plans:

- Define system architecture to include command and control requirements.
- Analyze tradeoffs between sensing performance, target location and referencing designs, data rates, and smart processing aboard the small UAV.
- Develop candidate designs at different points of these trade-off curves.
- Simulate each design over a suite of missions and select the design that provides the best overall actionable-ID capability.
- Brassboard and install the selected sensor, signal processing, flight control and data link software on a recoverable test platform.
- Construct and test entire prototype systems.

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	FY 2004	FY 2005	FY 2006	FY 2007
Urban Warfare Robotic Surveillance (URS)	0.000	2.000	4.605	7.444

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

(U) Program Plans:

- Select a baseline set of sensors, data links, and platforms.
- Design a flexible physical and logical architecture for a baseline URS system.
- Derive tasks and functions from standard urban reconnaissance operations plans.
- Construct a software testbed where candidate system components can be exercised in a synthetic urban battlespace.
- Develop alternative sensor models and algorithms (signal processing, object detection, object recognition, mapping, correlation, tracking, and route generation and communications management).
- Compare alternatives in the synthetic testbed. Select combinations that offer the most robust and effective performance.
- Build a hardware testbed incorporating selected component sensors and algorithms.
- Exercise test platforms in a series of increasingly difficult mission/environment combinations.
- Improve sensors or algorithms that limit performance.

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	FY 2004	FY 2005	FY 2006	FY 2007
Home Field	0.000	8.500	12.652	13.989

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

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

(U) Program Plans:

- Demonstrate a 3D-model method that uses distributed video and LADAR cameras in a mixed urban environment.
- Demonstrate the ability to extract architectural features, such as windows and doors from close-in imagery.
- Demonstrate an effective man-machine interface to edit/update the extracted features.
- Demonstrate a model update approach that keeps the urban cartographic representation current.
- Demonstrate rewritable holograms, large format (6' x 6') holograms, and a video-rate hologram.

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	FY 2004	FY 2005	FY 2006	FY 2007
Adaptive Reflective Middleware Systems	4.945	5.800	6.120	5.360

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

(U) Program Plans:

- Define and prototype adaptive protocols, algorithms, patterns, and technologies.
- Enforce security policies to enhance and support secure global resource allocation, scheduling, and control; ensure stability and dependability across the network-centric TSCE.
- Develop robust meta-programming policies and mechanisms based on standards-based middleware.
- Demonstrate the dynamic flexibility and QoS provisioning in the fourth DD(X) TSCE release.
- Define and prototype reflective techniques for synthesizing optimized distributed, real-time, and embedded middleware.
- Develop required information models, algorithms, and technologies; configure customizable, standards-compliant TSCE middleware and applications.
- Develop robust adaptive protocols, algorithms, patterns, and technologies based on standard middleware.
- Demonstrate enforcement of the security policies for global resource allocation, scheduling, and control in the fifth DD(X) TSCE release.
- Develop and demonstrate robust reflective techniques for synthesizing optimized standards-based middleware in the sixth DD(X) TSCE release.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Pre-Conflict Anticipation and Shaping (PCAS)	0.000	0.000	4.825	6.188

(U) The Pre-Conflict Anticipation and Shaping (PCAS) program will develop and integrate a range of preconflict anticipatory and shaping technologies into a unified system for stabilizing operations capabilities through conflict avoidance and strategic surprise prevention. PCAS technologies include computational social science modeling and simulation, scenario generation, evolutionary programming, planning, and multiplayer gaming. When integrated, these technologies allow combatant commanders and senior decision makers to understand and anticipate the societal/regional indicators that precipitate instability and conflict within an area of responsibility, then mitigate the impact of that instability. The PCAS system will be tested and validated against current state-of-the-art practices, such as advisory support staff that provide counsel by creating personalized reports about an area of operations using idiosyncratic mental models and research from open source materials. The goal of PCAS' more powerful societal/regional models is an integrated perspective encompassing, in a consistent way, all the dimensions of social change (e.g., geo-political, socio-economic, cultural).

(U) Program Plans:

- Identify a suite of emerging computational technologies (simulation, game theory, genetic algorithms) that can be applied to predict social change.
- Select a representative set of geographical regions which are expected to range from stable to highly unstable social dynamics.
- Obtain a large corpus of data describing the selected regions.
- Build tools to automatically translate the data corpus into a form usable by the suite of computational techniques.
- Build prototypes of software tools based on the identified technologies.
- Conduct regular experiments comparing predictions of the identified techniques with real-world events.
- Make rugged and operational the remaining techniques to form tools that can be transitioned to joint intelligence centers or the staff at Combatant Commands.

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	FY 2004	FY 2005	FY 2006	FY 2007
Diagnostic Network Economies	0.000	0.000	6.000	9.000

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

(U) Program Plans:

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

	FY 2004	FY 2005	FY 2006	FY 2007
NASEC Through Wall Radar Imaging	0.000	2.550	0.000	0.000

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

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(U) Other Program Funding Summary Cost:

- Not Applicable.