| Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Defense Advanced Research Projects Agency | | | | | | | | | | DATE: February 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | | | | | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | | | | | | |
| **COST ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012 Base** | **FY 2012 OCO** | **FY 2012 Total** | **FY 2013** | **FY 2014** | **FY 2015** | **FY 2016** | **Cost To Complete** | **Total Cost** |
| Total Program Element | 240.663 | 224.378 | 206.422 | - | 206.422 | 217.032 | 198.916 | 211.247 | 225.047 | Continuing | Continuing |
| TT-03: *NAVAL WARFARE TECHNOLOGY* | 42.217 | 45.328 | 35.855 | - | 35.855 | 53.486 | 45.371 | 39.392 | 39.392 | Continuing | Continuing |
| TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY* | 30.899 | 18.911 | 34.896 | - | 34.896 | 50.308 | 51.551 | 50.609 | 50.609 | Continuing | Continuing |
| TT-06: *ADVANCED TACTICAL TECHNOLOGY* | 74.728 | 67.308 | 63.719 | - | 63.719 | 41.184 | 29.642 | 34.716 | 52.516 | Continuing | Continuing |
| TT-07: *AERONAUTICS TECHNOLOGY* | 26.915 | 34.692 | 23.042 | - | 23.042 | 27.773 | 28.655 | 42.806 | 42.806 | Continuing | Continuing |
| TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* | 65.904 | 58.139 | 48.910 | - | 48.910 | 44.281 | 43.697 | 43.724 | 39.724 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

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

The Naval Warfare Technology project develops advanced enabling technologies for a broad range of naval requirements.  Technologies under development will increase survivability and operational effectiveness of small and medium surface vessels in rough seas and demonstrate advanced technologies for hypersonic flight. New areas to be investigated include ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations and unmanned sea vehicles for anti-submarine warfare.

The Advanced Land Systems project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations.  The emphasis is on developing affordable technologies that will enhance the military's effectiveness while decreasing the exposure of U.S. or allied forces to enemy fire.  Advanced manufacturing demonstration activities are also funded.

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

| Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Defense Advanced Research Projects Agency | DATE: February 2011 |
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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 a hybrid ground/air vehicle, an advanced helicopter rotor capable of being optimized for each mission, and robust study efforts.

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, predictive modeling tools to evaluate failing nation states and identify potential hot spots, and social networking approaches to identify and track potential terrorist cells.

| **B. Program Change Summary ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012 Base** | **FY 2012 OCO** | **FY 2012 Total** |
|---|---|---|---|---|---|
| Previous President's Budget | 248.683 | 224.378 | 260.518 | - | 260.518 |
| Current President's Budget | 240.663 | 224.378 | 206.422 | - | 206.422 |
| Total Adjustments | -8.020 | - | -54.096 | - | -54.096 |
| • Congressional General Reductions | | - | | | |
| • Congressional Directed Reductions | | - | | | |
| • Congressional Rescissions | - | - | | | |
| • Congressional Adds | | - | | | |
| • Congressional Directed Transfers | | - | | | |
| • Reprogrammings | -1.424 | - | | | |
| • SBIR/STTR Transfer | -6.596 | - | | | |
| • TotalOtherAdjustments | - | - | -54.096 | - | -54.096 |

| **Congressional Add Details ($ in Millions, and Includes General Reductions)** | **FY 2010** | **FY 2011** |
|---|---|---|
| **Project:** TT-03: *NAVAL WARFARE TECHNOLOGY* | | |
| Congressional Add: *Center of Excellence for Research in Ocean Sciences (CEROS)* | 8.000 | - |
| Congressional Add: *SeaCatcher Unmanned Aircraft Launch and Recovery System* | 1.600 | - |
| Congressional Add Subtotals for Project: TT-03 | 9.600 | - |
| Congressional Add Totals for all Projects | 9.600 | - |

**Change Summary Explanation**

FY 2010: Decrease reflects internal below threshold reprogrammings and the SBIR/STTR transfer.

FY 2012: Decrease reflects the end of programs such as EXACTO and Formation Flight in order to emphasize new directed energy efforts, social networking analysis and manufacturing efforts. In addition, the decrease also includes Defense Efficiencies for contractor staff support.

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|---|---|---|

| COST ($ in Millions) | FY 2010 | FY 2011 | FY 2012 Base | FY 2012 OCO | FY 2012 Total | FY 2013 | FY 2014 | FY 2015 | FY 2016 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-03: *NAVAL WARFARE TECHNOLOGY* | 42.217 | 45.328 | 35.855 | - | 35.855 | 53.486 | 45.371 | 39.392 | 39.392 | Continuing | Continuing |

## A. Mission Description and Budget Item Justification

The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements.  Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities such as drag reduction, ship stability, hypersonic missiles, logistically friendly distributed lighting systems, ship self defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, and high bandwidth communications.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| *Title:* Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV)<br><br>*Description:* The Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV) program has three primary goals: (1) to build and demonstrate an X-Ship with beyond state-of-the-art platform performance based on clean sheet design for unmanned operation, (2) demonstrate the technical viability of operating autonomous unmanned ships at theater or global ranges under a sparse remote supervisory control model, and (3) leverage unique ACTUV characteristics to transition a game changing ASW capability to the Navy.  By establishing the premise that a human is never intended to step on board at any point in the operational cycle, ACTUV concepts can take advantage of an unexplored design space that eliminates or modifies conventional ship design constraints such as internal arrangement, reserve buoyancy, and dynamic stability in order to achieve disproportionate speed, endurance, and payload fraction.  The resulting unmanned naval vessels must possess sufficient situational awareness and autonomous behavior capability to operate in full compliance with the rules of the road and maritime law to support safe navigation for operational deployments spanning thousands of miles and months of time.  When coupled with innovative sensor technologies, the ACTUV system provides a low cost unmanned system with a fundamentally different operational risk calculus that enables game changing capability to detect and track even the quietest diesel electric submarine threats. Key technical areas include unmanned naval vessel design methodologies, ship system reliability, high fidelity sensor fusion to provide an accurate world model for autonomous operation, novel application of sensors for ASW tracking, and holistic system integration due to unique optimization opportunities of the ACTUV system.<br><br>This effort will also explore a Tactically Expandable Maritime Platform (TEMP) concept to develop and demonstrate macroscopic integrated systems built up from International Organization for Standardization (ISO) modular technologies that can be operated from unmodified commercial container ships and deliver credible naval capability for high priority missions.  TEMP will develop critical enabling modular technologies and evaluate the feasible range of naval missions that can be serviced from this highly flexible and cost effective unconventional force structure model.  An initial mission to be explored will be the modular sea depot | 9.900 | 18.000 | 19.000 |

| Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency | | DATE: February 2011 |
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| concept to enable a remote unmonitored refueling capability for small craft; enabling independent operation from host ships. TEMP will also evaluate a Humanitarian Assistance and Disaster Relief (HA/DR) mission, engineering a modular first responder capability that allows the rapid force closure capability of TEMP to deliver immediate life saving operations in the hours and days following a disaster event, prior to the time that conventional platforms and organizations are able to respond. | | | |

*FY 2010 Accomplishments:*
- Conducted mission-focused integrated system concept development for ACTUV.
- Made ACTUV critical enabling technology assessments.
- Conducted ACTUV producibility and manufacturing sourcing analysis.
- Initiated ACTUV program concept design and risk reduction development activity.
- Completed exploratory studies validating operational, legal, and economic viability of the TEMP concept.

*FY 2011 Plans:*
- Execute multiple comprehensive integrated system concept design activities for ACTUV including supporting technology surveys, concept of operations development, preliminary operational performance assessments, and fabrication planning.
- Complete sensor and autonomy risk reduction and proof of principle testing for ACTUV.
- Develop ACTUV system concept of operations and conduct preliminary operational performance assessments.
- Complete ACTUV user assessment of strategic and operational value.
- Integrate preliminary system performance specifications from competing system concepts into ACTUV best-of-breed system performance specification for the demonstration activity.
- Initiate ACTUV integrated prototype detailed design, fabrication, and demonstration activity.
- Initiate TEMP HA/DR system preliminary design activity.
- Conduct stakeholder coordination and system requirements definition for the TEMP HA/DR system.
- Complete TEMP Modular Sea Depot detailed design, prototype fabrication, and developmental testing.
- Fabricate and test TEMP Modular Sea Depot prototype.

*FY 2012 Plans:*
- Complete ACTUV system preliminary design and conduct preliminary design review.
- Demonstrate critical enabling technologies for ACTUV.
- Develop ACTUV surrogate hardware-in-the-loop system.
- Complete ACTUV concept of operations and preliminary operational performance assessments.
- Commence ACTUV system detailed design.
- Complete TEMP HA/DR critical technology risk reduction demonstrations.
- Complete TEMP HA/DR preliminary design activity and conduct a preliminary design review.

| Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency | | DATE: February 2011 |
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| -  Conduct TEMP Modular Sea Depot prototype operational demonstration. | | | |
| *Title:* Sea Change | - | - | 10.000 |
| *Description:* Sea Change is a portfolio of disruptive approaches to critical operational challenges in the maritime domain.  The goal of the Sea Change program is to develop integrated system technologies that offer fundamentally new capabilities to address long-standing operational limitations of naval forces.  Sea Change focus areas include platform concepts to overcome naval force structure challenges to increase operational capability and efficiency of maritime systems and development of standoff technologies for rapid defeat of anti-access mines through a hydroacoustic anti-mine array.  The hydroacoustic anti-mine array effort will explore the technical feasibility of a novel mine clearance approach using coordinated high energy density acoustic sources to deliver standoff clearance of mines throughout the water column and on the ocean bottom.  By eliminating all explosive neutralizers and maintaining effectiveness with uncertain mine identification and location, the hydroacoustic anti-mine array concept has the potential to achieve dramatic reductions in area mine clearance timelines.<br><br>*FY 2012 Plans:*<br>-  Complete concept studies and operational assessments of novel maritime propulsion approaches.<br>-  Complete proof of principle testing for hydroacoustic anti-mine array source technology.<br>-  Conduct design activity for novel propulsion system proof of principle demonstration.<br>-  Initiate hydroacoustic anti-mine array preliminary design activity and conduct developmental risk reduction testing. | | | |
| *Title:* Caiman | - | 6.000 | 6.855 |
| *Description:* The Caiman program will develop a prototype amphibious robotic vehicle which will navigate tropical rivers autonomously for long range/long duration missions (~100 kilometers and ~7+ days) while gathering intelligence.  Navigating tropical rivers requires traversing long stretches of sandbars, very shallow water and avoiding small to large obstacles.  It also demands new advances in perception, autonomy and locomotion to enable the system to make progress in cluttered, shallow waters, including occasionally exiting the water, traversing ground such as sandbars, and then reentering.  The Caiman mission is targeted for the interface between water and land, which will result in the vehicle being able to access riverine and swamp areas which are currently inaccessible.<br><br>*FY 2011 Plans:*<br>-  Develop, analyze, and assess preliminary designs to achieve a system capable of a hundred kilometers of travel over a 7 day mission.<br>-  Simulate water to land to water transitions to validate design. | | | |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Build subsystems that prove design validity.<br><br>*FY 2012 Plans:*<br>- Complete critical design review and integration plan.<br>- Initiate demonstration system fabrication.<br>- Conduct final pre-assembly bench testing. | | | |
| *Title:* Very High Speed Vessel (VHSV)<br><br>*Description:* The Very High Speed Vessel (VHSV) program will explore the development of a small tactical surface vessel capable of protecting high value naval vessels in contested littoral environments.  The program will evaluate tactical mobility, mission endurance, lethality, and survivability that is well beyond that of any current or proposed littoral warfare platform.  The vessel will be designed to operate as an unmanned naval combat system with an integrated control system and weapons suite which will be optimized to defend against irregular naval warfare threats such as fast inshore attack crafts, high speed swarming combatant boats, and conventional diesel submarines operating in shallow coastal waters.  The VHSV system will leverage emerging developments in reconfigurable hull forms, fluid drag reduction, hybrid naval propulsion design, and dynamic control in fully cavitated flow to develop a vessel with significantly superior maximum speed, endurance, and seakeeping in elevated sea states.<br><br>*FY 2011 Plans:*<br>- Conduct military and tactical utility studies and establish seaframe and weapons development metrics.<br>- Perform advanced hullform technology studies and establish vessel performance limits. | - | 4.207 | - |
| *Title:* Super-Fast Submerged Transport (Underwater Express)<br><br>*Description:* The Super-Fast Submerged Transport (Underwater Express) program  will explore the application of supercavitation technology to underwater vehicles, enabling high speed transport of personnel and/or supplies.  The inherent advantages of traveling underwater are: the ability to transit undetected, no radar or visible signature, and avoidance of rough sea conditions that may limit or deny mission execution.  Supercavitation places the vehicle inside a cavity where vapor replaces the water, and drag due to fluid viscosity is reduced by orders of magnitude, thus reducing the power requirement dramatically.  This program will use modeling, simulation, experiments and testing to develop the understanding of the physical phenomena associated with supercavitation and the application to underwater vehicles.  Innovative failsafe controls will be required for stability and maneuverability at speed.  The program will culminate in an at-sea demonstration of a submerged unmanned vehicle capable of supercavitating operations and autonomous maneuvering.<br><br>*FY 2010 Accomplishments:* | 13.230 | 7.241 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Completed design, fabrication and component testing of a scaled vehicle.<br>- Analyzed vehicle performance for speed, power and stability.<br>- Completed development of vehicle control system.<br>- Modified vehicle systems for at-sea testing series based on testing results.<br><br>*FY 2011 Plans:*<br>- Complete at-sea testing of a scaled vehicle.<br>- Analyze vehicle performance for speed, power and stability. | | | |
| *Title:* Submersible Aircraft<br><br>*Description:* This program will combine the speed and range of an airborne platform with the stealth of an underwater vehicle by developing a vessel that can both fly and submerge. The program will exploit lightweight materials, unique dynamic structures and advanced propulsion systems to overcome the technical barriers to achieving this capability. If successful, the program will enable insertion and extraction of special operations and expeditionary forces at greater ranges, and higher speeds in locations not previously accessible with minimal direct support from additional military assets. The program goals are to demonstrate a vessel capable of multimodal operations (airborne, surface, and submerged) and that can easily transition between these modes.<br><br>*FY 2010 Accomplishments:*<br>- Initiated concept design studies and feasibility analysis in order to quantify extent of possible operational envelope.<br>- Began to identify key technology limitations and performance objectives that need to be overcome in order to achieve concept design.<br><br>*FY 2011 Plans:*<br>- Complete developmental activities including modeling and experiments, demonstrating technologies, and approaches that can overcome the identified performance objectives.<br>- Complete objective system design based on the results of developmental activities, providing an accurate projection of the systems operational envelope. | 4.518 | 4.000 | - |
| *Title:* Non-traditional Active Sonar<br><br>*Description:* The goal of the Non-traditional Active Sonar program is to develop alternative solutions for anti-submarine warfare active sonar. Given the trend of submarine quieting, passive sonar is of diminishing value to the Navy. The existing alternatives are high-power active sonar systems that are overt and difficult to use in peace time, especially in far forward or congested littoral areas. The program will investigate new approaches which exploit special acoustic phenomena and techniques, through | 4.969 | 5.880 | - |

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| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012** |
|---|---|---|---|
| advanced active sonar signal processing to achieve advanced active sonar.  Emphasis is on data-driven algorithm development applicable across existing Navy hydrophone sensor arrays.<br><br>*FY 2010 Accomplishments:*<br>- Developed initial processing algorithms for use with the initial data set.<br>- Exercised the algorithms with surrogate and simulated data.<br>- Conducted controlled data collection with surrogate sources and targets.<br>- Developed and assessed algorithms using collected data.<br><br>*FY 2011 Plans:*<br>- Iterate on algorithm designs to assess detection capability (e.g., range) and extrapolate performance to other environments and concepts of operations.<br>- Conduct at-sea data collection with real targets, and identify existing data to support assessment of processing algorithm performance under realistic conditions.<br>- Demonstrate processing feasibility for relevant system designs. | | | |
| **Accomplishments/Planned Programs Subtotals** | 32.617 | 45.328 | 35.855 |

| | **FY 2010** | **FY 2011** |
|---|---|---|
| *Congressional Add:* Center of Excellence for Research in Ocean Sciences (CEROS) | 8.000 | - |
| *FY 2010 Accomplishments:* -  Selected projects and monitored progress of ocean related technologies of high interest to the DoD. | | |
| *Congressional Add:* SeaCatcher Unmanned Aircraft Launch and Recovery System | 1.600 | - |
| *FY 2010 Accomplishments:* -  Continued to explore launch and recovery system concepts. | | |
| **Congressional Adds Subtotals** | 9.600 | - |

**C. Other Program Funding Summary ($ in Millions)**

   N/A

**D. Acquisition Strategy**

   N/A

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**E. Performance Metrics**

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

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|---|---|---|

| COST ($ in Millions) | FY 2010 | FY 2011 | FY 2012 Base | FY 2012 OCO | FY 2012 Total | FY 2013 | FY 2014 | FY 2015 | FY 2016 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY* | 30.899 | 18.911 | 34.896 | - | 34.896 | 50.308 | 51.551 | 50.609 | 50.609 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

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 will also explore novel design technologies for the manufacture of ground vehicles and new tools for systems assessments of emerging DARPA technologies.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| **Title:** C-Sniper | 9.955 | 8.401 | 0.896 |

**Description:** Based on promising results obtained under the Crosshairs program, the C-Sniper effort will develop the capability to detect and neutralize enemy snipers before they can engage U.S. Forces. The program will deliver a field testable prototype suitable for experimentation on a compatible vehicle such as the Stryker. The C-Sniper system will identify threats before they can fire. Enemy snipers may be operating both with and without telescopic sights and other optical systems in highly cluttered urban environments. The C-Sniper system will operate day and night from a static or mobile military vehicle and will provide the operator with sufficient information to make a timely engagement decision. Once a decision is made, the C-Sniper will provide data and control to point and track the on-board weapon to the selected target. The final decision to fire the weapon will be left to the operator.

*FY 2010 Accomplishments:*
- Demonstrated system capability to correctly detect optical systems in a highly cluttered urban environment.
- Conducted trade studies on camera systems and laser systems to optimize design.

*FY 2011 Plans:*
- Develop, deliver and demonstrate the operation of C-Sniper on moving vehicles.
- Integrate C-Sniper on a test vehicle and demonstrate full system capability.

*FY 2012 Plans:*
- Complete demonstration of fully integrated system capabilities.

| **Title:** Fast, Adaptable, Next Generation Ground Combat Vehicle (FANG) | - | - | 20.000 |
|---|---|---|---|

**Description:** The goals of the Fast, Adaptable, Next-Generation Ground Combat Vehicle (FANG) program are to employ a novel, model-based correct-by-construction design capability, a highly-adaptable foundry-style manufacturing capability, and design

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| crowd-sourcing methods to demonstrate 5X-10X compression in the timeline necessary to build an infantry fighting vehicle. The program seeks to develop an open-source development infrastructure for the aggregation of designer inputs applicable to complex electromechanical systems as well as software, and to exercise this infrastructure with a series of design challenges, leading to prize awards and builds of winning designs in a foundry-style, rapidly configurable manufacturing facility.  The design challenges will culminate in a complete build of a next generation infantry fighting vehicle to a requirements set loosely analogous to the Army's Ground Combat Vehicle-but executed on a roughly one-year timescale.  Additionally, the program will pursue an explicit outreach activity to high school-age students to teach the principles of model-based design and distributed foundry-style manufacturing to build a next-generation cadre of manufacturing innovators.  Initial ground vehicle design work is funded under the META program in PE 0602303E, Project IT-02.<br><br>*FY 2012 Plans:*<br>- Complete the development and begin operational testing of the crowd-sourced vehicle design environment.<br>- Perform experimental subsystem designs and subsequent design builds using the vehicle design environment as well as the iFAB foundry.<br>- Promulgate component model libraries, foundry capabilities, and objective design criteria for a mobility and drivetrain challenge.<br>- Conduct a competitive, crowd-sourced design challenge for the mobility and drivetrain subsystem of an infantry fighting vehicle.<br>- Continue high school outreach effort for the procurement, deployment, and utilization of a distributed additive manufacturing capability. | | | |
| *Title:* Adaptive System Assessment (ASA)<br><br>*Description:* The Adaptive System Assessment (ASA) program seeks to develop new tools, technologies, and techniques that enable efficient, rigorous, and informative readiness assessments of emerging and mature DARPA technology.  ASA will create rapid, composed, quantitative and qualitative simulations for systems and systems of systems, methods for reliably extrapolating the evaluation results from subsystem components to assess overall system potential performance, and methods for integrating virtual and live experimentation in realistic operational scenarios.  This program will create formal or empirical methods and tools for (semi-) automatically rating the maturity of systems according to Technology Readiness Level (TRL) or alternative measures, as well as extensions, enhancements, and alternatives to the TRL rating system.<br><br>*FY 2012 Plans:*<br>- Investigate the use of dynamic, reconfigurable, agile, virtual environment framework for the assessment of technologies in DoD systems.<br>- Initiate development of scalable simulation environment for adaptive assessment.<br>- Define simulation module format and interfaces for assessment simulation components. | - | - | 14.000 |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Develop initial virtual environments for assessment in two domains and produce prototype simulation based on a reconfigurable framework. | | | |
| **Title:** Magneto Hydrodynamic Explosive Munition (MAHEM)<br><br>**Description:** The Magneto Hydrodynamic Explosive Munition (MAHEM) program will demonstrate compressed magnetic flux generator (CMFG)-driven magneto hydrodynamically formed metal jets and self-forging penetrators (SFP) with significantly improved performance over explosively formed jets (EFJ) and fragments. EFJ and SFP are used for precision strike against targets such as armored vehicles and reinforced structures. Current technology uses chemical explosive energy to form the jets and fragments. This is highly inefficient and requires precise machining of the metal liners from which the fragments and jets are formed. Generating multiple jets or fragments from a single explosive is difficult and the timing of the multiple jets or fragments cannot be controlled. MAHEM offers the potential for higher efficiency, greater control, the ability to generate and accurately time multiple jets and fragments from a single charge, and the potential for aimable, multiple warheads (multimodal warhead) with a much higher EFJ velocity, hence increased lethality precision, than conventional EFJ/SFP. MAHEM could be packaged into a missile, projectile or other platform, and delivered close to target for final engagement. This could provide the warfighter with a means to address stressing missions such as: lightweight active self-protection for vehicles (potential defeat mechanism for a kinetic energy round), counter armor (passive, reactive, and active), mine countermeasures, and anti-ship cruise missile final layer of defense.<br><br>**FY 2010 Accomplishments:**<br>- Using theoretical models, began design of flux compression generator (FCG) components in preparation for fabrication and testing of the armature and stator configuration with static and dynamic loads.<br>- Designed and modeled shaped charge liners and magnetically formed penetrators (MFPs) that will provide maximum penetration against hardened targets of interest.<br><br>**FY 2011 Plans:**<br>- Design, fabricate and test a first-of-its-kind ring initiator to be used for the multimodal warhead configuration.<br>- Begin fabrication of armature for the multimodal warhead configuration.<br>- Complete fabrication of FCG components, shaped charge liners, and MFPs.<br>- Perform testing of FCG components.<br>- Test shaped charge liners and MFPs. | 1.759 | 1.210 | - |
| **Title:** Crosshairs<br><br>**Description:** The Crosshairs program seeks to develop a vehicle mounted threat detection and countermeasure system that will detect, locate, and engage enemy shooters against a variety of threats to include bullets, Rocket Propelled Grenades (RPGs), | 7.929 | 3.900 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| Anti-Tank Guided Missiles, and direct fired mortars, both stationary and on the move. Threat identification and localization will be accomplished in sufficient time to enable both automatic and man-in-the-loop responses. Phase I of the program focused on initial development and testing of the Crosshairs sensor system. Phase IA culminated with a static live fire test to determine the most effective candidate sensor system. During Phase IB, enhancements were made to the sensor system for on the move performance, and on the move testing against multiple threats was conducted. DARPA and the U.S. Army Rapid Equipping Force (REF) entered into an MOA for Phase IIA. Phase IIA consisted of a moving demonstration of the hardened, packaged, and enhanced Phase I sensor system on two networked HMMWVs, integration with candidate response systems, and testing and evaluation of the complete systems in relevant environments. The program is currently in Phase IIB. During this phase, the Crosshairs sensor system is being integrated with the Iron Curtain Active Protection System (IC-APS) on four up-armored vehicles. At the end of Phase IIB, the Crosshairs systems will be ready for field testing.<br><br>DARPA is working with the Army REF and the Project Manager Mine Resistant Ambush Protected Vehicles to validate the capabilities and initiate transition to combat forces in the 2010/2011 time frame.<br><br>*FY 2010 Accomplishments:*<br>- Completed integration of the IC-APS and CrossCue system.<br>- Validated system performance and field-worthiness through testing by the Army Test and Evaluation Command.<br><br>*FY 2011 Plans:*<br>- Demonstrate final integrated system capability, including active protection, in live fire tests.<br>- Transition Crosshairs technology to the military. | | | |
| *Title:* Rocket Propelled Grenade (RPG) Nets<br><br>*Description:* The goal of the Rocket Propelled Grenade (RPG) Nets program is to develop a near-term counter RPG net system that has performance at least equivalent to bar or slat armor, but that is lighter and easier to deploy; and a mid-term net-based system with active elements that has greatly improved performance. Development of these systems will be supported by modeling to enhance understanding of the net interactions and with extensive live fire testing against RPGs. Successful candidates have been installed on vehicles for evaluation in an operational context. DARPA is working with the Marine Program Manager for Motor Transport to develop, test and transition this capability to combat forces.<br><br>*FY 2010 Accomplishments:*<br>- Installed near-term net systems on military vehicles and performed initial user evaluation.<br>- Commenced evaluation of near-term net system and initiated transition.<br><br>*FY 2011 Plans:* | 3.306 | 0.900 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Complete evaluation of near-term net system and initiate transition. | | | |
| **Title:** Helicopter ALert and Threat Termination (HALTT)<br><br>**Description:** The Helicopter ALert and Threat Termination (HALTT) program will provide Army and Navy/Marine helicopters with a way to detect small arms and provide shooter location to improve their ability to respond.  System effectiveness with emphasis on low false alarm rates is critical.  The program goal is to successfully demonstrate protection of helicopters by automatic threat detection of small arms with an "o'clock" accuracy in azimuth as well as elevation and range to shooter.<br><br>**FY 2010 Accomplishments:**<br>- Installed prototype HALTT systems on platforms for CONOPS evaluations.<br>- Demonstrated the HALTT prototype system in operational evaluation scenarios.<br>- Enhanced sensor design and platform interface.<br>- Integrated the acoustic sensors on unmanned aircraft to determine true system accuracy.<br><br>**FY 2011 Plans:**<br>- Integrate and demonstrate acoustic system on multiple platforms.<br>- Demonstrate a fully integrated HALTT system in operational scenarios. | 3.950 | 2.500 | - |
| **Title:** Lightweight Ceramic Armor (LCA)<br><br>**Description:** The Lightweight Ceramic Armor (LCA) program is leveraging recent breakthroughs in novel ceramic fabrication processes developed in the Materials Processing Technology project to drive a dramatic performance shift in the trade-off between weight and ballistic projectile protection of body armor.  Currently fielded body armor is heavy and its weight and bulk limit a soldier's agility and mobility.  Utilizing recent breakthroughs in unconventional ceramics processing technology, the LCA program has demonstrated greater than ten percent reduction in weight for equal ballistic protection.<br><br>**FY 2010 Accomplishments:**<br>- Demonstrated an initial ten percent reduction in weight for equal performance compared to currently fielded body armor systems.<br>- Investigated the potential for significantly improved ballistic characteristics of meta-structured ceramic systems by incorporating multiple materials layers in a monolithic plate and combining it with high performance energy absorbing backing materials.<br>- Evaluated the capability of various ceramic materials and layering configurations to defeat armor piercing projectiles, and demonstrated threat defeat with multiple system configurations.<br>- Demonstrated key manufacturing steps at pilot scale throughput with consistent and reliable yielded ceramic part performance.<br><br>**FY 2011 Plans:** | 2.000 | 2.000 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Scale the unconventional ceramic consolidation process to consistently produce curved ceramic plates up to specified size.<br>- Develop the procedure (including preparation, consolidation, and cooling) to manufacture side ballistic inserts consistent with U.S. Army specifications.<br>- Evaluate the ballistic performance of the scaled, uniquely layered armor system against multiple armor piercing threats.<br>- Validate the capability to produce a full-size side ballistic armor insert at greater than ten percent reduction in weight as compared to current state-of-the-art solutions.<br>- Demonstrate the capability to produce at least 10,000 ceramic plates per year. | | | |
| *Title:* Recognize Improvised Explosive Devices and Report (RIEDAR)<br><br>*Description:* The goal of the Recognize Improvised Explosive Devices and Report (RIEDAR) program was to develop and demonstrate a capability for stand-off detection of various devices.<br><br>*FY 2010 Accomplishments:*<br>- Investigated designs for sub-system consisting of optical detector and compact laser for detection of explosives. | 1.000 | - | - |
| *Title:* Rocket Propelled Grenade (RPG) Pre-launch Detection and Cueing<br><br>*Description:* The Rocket Propelled Grenade (RPG) Pre-launch Detection and Cueing program explored the development of an omni directional, visual, vehicle mounted surveillance system for threat detection using cognitive swarm recognition technology to rapidly detect and identify the locations of attackers with RPGs before they are launched.<br><br>*FY 2010 Accomplishments:*<br>- Analyzed and documented promising methods for detection and classification algorithms. | 1.000 | - | - |
| **Accomplishments/Planned Programs Subtotals** | 30.899 | 18.911 | 34.896 |

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

**D. Acquisition Strategy**
   N/A

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

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| COST ($ in Millions) | FY 2010 | FY 2011 | FY 2012 Base | FY 2012 OCO | FY 2012 Total | FY 2013 | FY 2014 | FY 2015 | FY 2016 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-06: *ADVANCED TACTICAL TECHNOLOGY* | 74.728 | 67.308 | 63.719 | - | 63.719 | 41.184 | 29.642 | 34.716 | 52.516 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

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) new approaches for training and mission rehearsal in the tactical/urban environment. Additionally, this project will develop new tactical systems for enhanced air vehicle survivability, precision optics, electronic warfare, and advanced air breathing weapons.

| **B. Accomplishments/Planned Programs ($ in Millions)** | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| *Title:* High Energy Liquid Laser Area Defense System (HELLADS) | 18.989 | 20.894 | 29.453 |

*Description:* The goal of the High Energy Liquid Laser Area Defense System (HELLADS) program is to develop a high-energy laser weapon system (150 kW) with an order of magnitude reduction in weight compared to existing laser systems. With a weight goal of <5 kg/kW, HELLADS will enable high energy lasers (HELs) to be integrated onto tactical aircraft, and will significantly increase engagement ranges compared to ground-based systems, enabling high precision, low collateral damage, and rapid engagement of fleeting targets for both offensive and defensive missions. The HELLADS program has completed the design and demonstration of a revolutionary prototype unit cell laser module. That unit cell demonstrated power output and is demonstrating optical wavefront performance that supports the goal of a lightweight and compact 150 kW high energy tactical laser weapon system. Two unit cell module designs with integrated power and thermal management systems were fabricated and tested; they demonstrated an output power exceeding 34 kW. Based on the results of the unit cell demonstration, additional laser modules will be replicated and connected to produce a 150 kW laser that will be demonstrated in a laboratory environment. The 150 kW laser will then be integrated with beam control, prime power, thermal management, safety, and command and control subsystems all based upon existing technologies to produce a ground-based laser weapon system field demonstrator. The capability to shoot down tactical targets such as surface-to-air missiles and rockets and the capability to perform ultra-precise offensive engagements will be demonstrated in a realistic ground test environment. Additional funding for this integration effort will be provided for HELLADS testing in Project NET-01, PE 0603766E starting in FY 2011. The HELLADS laser will then be transitioned to the Air Force for modification and aircraft integration and flight testing.

*FY 2010 Accomplishments:*
- Completed a unit cell laser module with integrated power and thermal management subsystems and demonstrated required performance relative to power, run-time, weight, and volume.
- Completed the detailed design of a ground-based 150kW laser weapons system demonstrator.

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Initiated fabrication of the ground-based demonstrator laser weapon system.<br>- Initiated ground-based demonstrator laser weapon system component and subsystem testing.<br>- Started aircraft integration studies and design.<br><br>*FY 2011 Plans:*<br>- Complete unit cell performance optimization to obtain beam quality to support full system performance.<br>- Develop advanced diagnostic tools to assess high energy laser beam quality.<br>- Prescribe and build the active optical component to provide remaining correction of static and dynamic optical disturbances in the high energy laser.<br>- Continue subsystem testing of the ground-based demonstrator laser weapon system.<br>- Complete the detailed design of the 150 kW laser.<br>- Initiate the fabrication and laboratory testing of the 150kW laser.<br><br>*FY 2012 Plans:*<br>- Complete the fabrication of the 150 kW laser.<br>- Complete planning and preparations to integrate the 150 kW laser with the ground-based demonstrator laser weapon system.<br>- Complete subsystem testing of the ground-based demonstrator laser weapon system. | | | |
| *Title:* Aero-Adaptive/Aero-Optic Beam Control (ABC)<br><br>*Description:* The goal of the Aero-Adaptive/Aero-Optic Beam Control (ABC) program is to improve the performance of high-energy lasers on tactical aircraft, against targets in the aft field-of-regard.  In order to achieve a large field-of-regard, current optical turret designs protrude into the flow.  This causes severe optical distortions in the aft field-of-regard due to turbulence in the wake and the unsteady shock movement over the aperture.  These distortions decrease the power flux on target (the measure of lethality for a directed energy system) and consequently limit the utility of directed energy systems to targets in the forward field-of-regard.  This program will optimize flow control strategies for pointing angles in the aft field-of-regard.  The program will also explore the ability to synchronize the flow control system with adaptive optics.  This effort will initially focus on wind tunnel testing to prove the feasibility of steady and periodic flow control techniques to reduce or regularize the large scale turbulent structures surrounding an optical turret.  These tests will culminate in a hardware-in-the-loop demonstration utilizing flow control with an adaptive optics system in a full-scale wind tunnel test for the turret.  Following successful wind tunnel demonstrations, a preliminary design of a flight test turret incorporating flow control will be undertaken.<br><br>*FY 2010 Accomplishments:*<br>- Developed methods, designed and fabricated optics, electronics, and mechanics for full-scale wind tunnel test of turret.<br>- Conducted wind tunnel tests of selected turret to characterize the uncontrolled flow in preparation for flow control entries. | 4.446 | 5.100 | 5.084 |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Designed and implemented ABC flow control actuators for full-scale wind tunnel test.<br>- Performed bench-level evaluation of system functionality.<br><br>*FY 2011 Plans:*<br>- Perform initial testing of full-scale flow control in open-loop wind tunnel testing of ABC turret.<br>- Demonstrate and validate ABC concept with closed-loop adaptive optic system and flow control in a full-scale wind tunnel test.<br><br>*FY 2012 Plans:*<br>- Identify new mission capabilities enabled by aero-effects control technology.<br>- Commence preliminary design of a flight test turret incorporating flow control and optical compensation. | | | |
| *Title:* Excalibur*<br><br>*Description:* *Excalibur aggregates the following programs: High Power Efficient and Reliable Laser Bars (HiPER), Revolution in Fiber Lasers (RIFL), and Coherently Combined High-Power Single-Mode Emitters (COCHISE)<br><br>The Excalibur program will develop high-power electronically-steerable optical arrays, with each array element powered by a fiber laser amplifier.  These fiber-laser arrays will be sufficiently lightweight, compact, and electrically efficient to be fielded on a variety of platforms with minimal impact to the platform's original mission capabilities.  Each array element will possess an adaptive-optic capability to minimize beam divergence in the presence of atmospheric turbulence, together with wide-field-of-view beam steering for target tracking.  With each Excalibur array element powered by high power fiber laser amplifiers (at up to 3 kilowatts per amplifier), high power air-to-air and air-to-ground engagements will be enabled that were previously infeasible because of laser system size and weight.  In addition, this program will also develop kilowatt-class arrays of diode lasers that will provide the higher spatial and temporal bandwidths needed to correct for the increased air turbulence effects encountered in ground-to-ground engagements.  Excalibur arrays will be conformal to aircraft surfaces and scalable in size and power by adding elements to the array.  By defending airborne platforms such as unmanned aerial vehicles against proliferated, deployed, and next-generation man-portable air-defense systems (MANPADS), Excalibur will enable these reconnaissance platforms to fly at lower altitude and obtain truly persistent, all-weather  ground reconnaissance despite low-lying cloud cover.  Further capabilities include multichannel laser communications, target identification, tracking, designation, precision defeat with minimal collateral effects as well as other applications.<br><br>The Excalibur Budget Activity 2 program will develop the core set of laser components for efficiently driving elements of high-power electronically steerable optical arrays, namely, high-power coherently- and spectrally-combinable fiber laser amplifiers, high-brightness laser diodes for efficiently pumping the fiber laser amplifiers, and kW-class single-mode laser diode arrays.  These | 18.423 | 17.294 | 21.325 |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| components will be designed to work in tandem with the high-power laser amplifier arrays developed under the Budget Activity 3 Excalibur program in PE 0603739E, Project MT-15.<br><br>***FY 2010 Accomplishments:***<br>- Demonstrated a coherently combinable fiber laser amplifier with an output of 1 kW, electrical efficiency of 30.6%, and near-perfect, diffraction-limited beam divergence.<br><br>***FY 2011 Plans:***<br>- Develop 3-kW coherently combinable fiber laser amplifiers at electrical efficiencies exceeding 30% and with near-perfect beam divergence (better than 1.4x diffraction-limited).<br>- Demonstrate compact 100-W coherent array of single-mode laser diodes.<br>- Demonstrate a single laser diode bar (1 cm x 5 mm) with an output power of 500 W and a lifetime of 100 hours on a compact low thermal-resistance (<60mK/W) heat sink.<br><br>***FY 2012 Plans:***<br>- Demonstrate compact 500-W coherent array of single-mode laser diodes.<br>- Demonstrate a single wavelength-stabilized laser diode bar coupled to an optical fiber (100-μm core, 0.22NA) with 200 W exiting from the fiber. | | | |
| ***Title:*** Polarizing Keyless Cryptography (POLKA)<br><br>***Description:*** Cryptographic security of the Department of Defense's point-to-point data links is fundamentally important and faces an emerging threat as encryption devices are rapidly out-paced by the increasing data rates of links. Building upon concepts developed under the Integrated Sensing and Processing program, the POLKA program will demonstrate a compelling all-optical encryption system that has the potential to meet the Department's needs. Traditional encryption techniques rely on mathematical algorithms implemented on electronic devices; POLKA will develop a physics-based, all-optical technique for encryption. Along with its transition partner, DARPA will analyze the theoretical and practical vulnerabilities of the POLKA system and demonstrate experimental verification of its efficacy.<br><br>***FY 2012 Plans:***<br>- Integrate optical encryption with Information Theoretic Security Code for secure high speed data transfer.<br>- Complete prototype development and testing of all-optical encryption system.<br>- Begin experimental verification of vulnerabilities. | - | - | 7.857 |
| ***Title:*** Integrated Sensing and Processing | 6.400 | 6.370 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| *Description:* 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, encryption and information exploitation functionality in sensor systems. This program will create tools enabling the design and global optimization of advanced sensor system architectures comprising fully interdependent networks of functional elements, each of which can fill the roles and functions of several distinct subsystems in current generation sensor systems. Payoffs will include improved performance with reduced complexity of hardware and software in a wide variety of systems, including agile adaptive arrays for missile seekers, unmanned air vehicles, and space-borne sensors; novel waveforms, and novel approaches to multiplexed hyper-spectral chemical/biochemical sensing systems.<br><br>*FY 2010 Accomplishments:*<br>- Extended graph topology to simplex methods to develop novel algorithms.<br>- Generated algorithms to provide flexible, movable, reactive border generation for dynamics and unpredictable events.<br>- Developed multi-body algorithms to enable formation flight and interaction of sensors in zero-gravity environments.<br>- Investigated technologies to enable novel, physics-based, high-speed network encryption approaches.<br><br>*FY 2011 Plans:*<br>- Develop stochastic topological theory of non-parametric statistics and apply to automatic target recognition problems.<br>- Develop clock-free strongly open-loop controls and information state estimation and comparison for minimal-sensing in localization and navigation problems.<br>- Test multi-body algorithms to enable formation flight and interaction of sensors in zero-gravity environments.<br>- Develop novel optical encryption design and initiate component development. | | | |
| *Title:* High Performance Algorithm Development<br><br>*Description:* The High Performance Algorithm Development programs identify, develop and demonstrate new mathematical paradigms enabling maximum performance at minimum cost in a variety of DoD systems applications. The programs look for opportunities to aggressively leverage the power of mathematical representations in order to effectively exploit large-scale computational resources as they apply to specific problems of interest. They also cultivate theoretical breakthroughs in areas of basic mathematics having relevance to emerging defense sciences and technologies. The products are typically advanced algorithms and design methodologies. DARPA is pursuing the development of well-conditioned fast algorithms and strategies for the exploitation of high-dimensional data (i.e., data with a high number of degrees of freedom) in order to deal with a variety of complex military problems including digital representation and analysis of terrain and other geospatial data, efficient high fidelity scattering computations of radar scattering for predictive design and exploitation of radar cross sections, and efficient automatic mapping and optimization of signal processing kernels onto advanced departmental computational hardware architectures. | 5.000 | 5.000 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| ***FY 2010 Accomplishments:***<br>- Implemented geometric theory of higher dimensional clustering for novel data analysis to produce user-friendly fast algorithms.<br>- Developed multi-parameter and multi-dimensional topological persistence algorithms to extract high dimensional, dynamic, hidden features in massive data sets across DoD applications; including communications, biology, neuroscience as well as classically important radar and other digitally represented applications.<br>- Developed taxonomy of systems representing different system dependencies, down times and recovery rates to be analyzed for survivability.<br>- Began investigating a new family of non-increasing stochastic processes that enables the replacement of propensity by probability in uncertainty modeling.<br><br>***FY 2011 Plans:***<br>- Develop an Ito-style stochastic calculus to build theoretical models to improve uncertainty prediction.<br>- Develop and use novel topological tools to analyze non-linear dynamical systems. | | | |
| ***Title:*** Training Superiority<br><br>***Description:*** The Training Superiority program will provide a new capability for military training by developing new approaches to increase technical competence.  This includes elements of human-tutor interactions integrated with emotional involvement of computer games coupled with the fidelity and feedback of Combat Training Center learning.  In addition, this thrust will scale-up new digital tutor methodologies capable of training at a high proficiency level in reduced time and deliver these to a large cohort of warfighters.<br><br>***FY 2010 Accomplishments:***<br>- Developed the underlying engine and the hardware/software architecture necessary to create a large scale Digital Tutor system, with focus on scaling, capacity and performance.<br>- Elaborated intrinsic, instrumental and extrinsic motivation models in order to maintain student motivation over two months of instruction demonstrated over one week.<br>- Ported two months of Navy IT-School content from a human-tutored course to the Digital Tutor.<br>- Created an automatic capability to identify students requiring remediation.<br>- Developed methodology for establishing correspondence between Digital Tutor content/training and existing Navy curriculum, to facilitate transition of Digital Tutor to Navy Schoolhouse.<br><br>***FY 2011 Plans:***<br>- Extend Natural Language Understanding to encompass the full range of the IT domain. | 8.900 | 8.400 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Create a semantic model, abstractions, and Application Program Interface (API) that allows Socratic dialogs capable of handling large number of semantic responses rather than a predefined set of answers.<br>- Complete full sixteen weeks of content in the Digital Tutor and integrate results of theoretical work.<br>- Demonstrate deployment to pier-side and harden the system (full course).<br>- Establish effectiveness of Digital Tutor system in creating Mastery-level students by conducting second IWARs competition between Digital Tutor trained students and Navy-selected Fleet experts. | | | |
| *Title:* RealWorld<br><br>*Description:* The RealWorld program exploits technical innovation and integration to provide any U.S. warfighter with the ability to open a laptop computer and rehearse a specific mission in the relevant geo-specific terrain, with realistic physics.  Because the system will be scalable and distributed, a warfighter can practice by himself, in a small group, or with as many other warfighters as needed for the mission over a local or distributed network, and across all relevant platforms (dismounts, vehicles, helicopters, and fast movers).  Most important is the understanding that RealWorld is not a static simulation; it is a simulation builder with applications across the spectrum of modern kinetic and non-kinetic warfare.  The program is building tools that allow warfighters to rapidly and easily build their own missions though the introduction of new methodology for building simulation software.  This methodology and adherence to a highly modular approach will cause a fundamental paradigm shift in the acquisition, as well as the construction, of DoD modeling and simulation products.<br><br>*FY 2010 Accomplishments:*<br>- Scaled to 1000 warfighter entities.<br>- Integrated meteorological capability so real-time weather can be imported into training and rehearsal scenarios.<br>- Demonstrated integration of data from Google Earth.<br>- Transformed pictures taken by a cell phone camera into a 3-D model capable of being ingested by a real-time 3-D engine.<br><br>*FY 2011 Plans:*<br>- Demonstrate ability to support joint air/land/sea operations.<br>- Integrate RealWorld with a mission planning/C2 system (e.g., in the Special Operations Mission Planning Environment (SOMPE)) and demonstrate two-way data flow.<br>- Add voice capability to avatar system.<br>- Create an application programming interface that will allow external artificial intelligence systems to be easily integrated into RealWorld. | 6.250 | 4.250 | - |
| *Title:* Fiber Laser Pulse Source (FLIPS) | 3.160 | - | - |
| | | | |

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|---|---|---|
| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-06: *ADVANCED TACTICAL TECHNOLOGY* |

| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012** |
|---|---|---|---|
| *Description:* The Fiber Laser Pulse Source (FLIPS) program evaluated concepts for a compact fiber-based laser system that generates short high-energy pulses, at a high average-power level, (pushing past fundamental limits of existing fiber-based laser amplifiers.)  Such a system could enable applications such as remote detection of biological and chemical agents, free space communications, advanced photolithography as well as long-range high-resolution laser-radar systems.<br><br>*FY 2010 Accomplishments:*<br>-  Developed concepts for power scaling of pulsed fiber lasers beyond the fundamental nonlinear limitations of individual amplifiers. | | | |
| *Title:* Efficient Mid-Wave Infrared Lasers (EMIL)<br><br>*Description:* The Efficient Mid-Wave Infrared Lasers (EMIL) program evaluated efficient solid-state coherent sources that can cover the atmospheric transmission bands in the mid-wave infrared (MWIR; 3-5 micrometers).  Infrared countermeasure (IRCM) systems in particular depend on intense sources at these bands.  The current generation IRCM systems utilize diode-pumped Thulium (Tm) lasers used to pump optical parametric oscillators, most commonly based on zinc germanium phosphide.<br><br>The lasers developed in this program operate across the three relevant bands within the MWIR at 10 W power with wall plug efficiencies of at least 10 percent.  By virtue of the enormous volumetric reduction (100-1000 times), power reduction (ten times), and superior pulse format (cw-operation), such sources are enabling new architectures and approaches permitting IRCM systems to be deployed on platforms (e.g., rotorcraft) which are highly vulnerable to Man Portable Air Defense Systems and other threats but for which current IRCM systems are prohibitive or are inadequate (e.g., unable to defeat staring sensors).<br><br>*FY 2010 Accomplishments:*<br>-  Demonstrated epitaxial growth and preliminary characterization of final structures. | 3.160 | - | - |
| **Accomplishments/Planned Programs Subtotals** | 74.728 | 67.308 | 63.719 |

**C. Other Program Funding Summary ($ in Millions)**

   N/A

**D. Acquisition Strategy**

   N/A

**E. Performance Metrics**

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

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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | R-1 ITEM NOMENCLATURE<br>PE 0602702E: *TACTICAL TECHNOLOGY* | PROJECT<br>TT-07: *AERONAUTICS TECHNOLOGY* |
|---|---|---|

| COST ($ in Millions) | FY 2010 | FY 2011 | FY 2012 Base | FY 2012 OCO | FY 2012 Total | FY 2013 | FY 2014 | FY 2015 | FY 2016 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-07: *AERONAUTICS TECHNOLOGY* | 26.915 | 34.692 | 23.042 | - | 23.042 | 27.773 | 28.655 | 42.806 | 42.806 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

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.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| *Title:* Transformer (TX) Vehicle<br><br>*Description:* The Transformer (TX) Vehicle program will examine the feasibility and approaches for developing a vertical take-off and landing (VTOL), road-worthy vehicle that can carry a 1,000 lb payload at a range of 250nm on a single tank of fuel.  With a flyable/roadable vehicle, the warfighter has the ability to avoid road obstructions as well as improvised explosive devices and ambush threats, providing flexibility for tactical military and personnel transport missions.  The primary focus of this program is to demonstrate the ability to build a ground vehicle that is capable of configuring into a VTOL air vehicle that provides sufficient flight performance and range, while carrying a payload that is representative of four troops with gear.  The enabling technologies of interest include hybrid electric drive, advanced batteries, stowable wing structures, ducted fan propulsion, lightweight materials, and advanced sensors and flight controls for stable transition from vertical to horizontal flight.  TX vehicles could be dispatched for downed airman recovery, for evacuating injured personnel from difficult-to-access locations, or to resupply isolated small units.  TX will also be suitable for enhanced company operations concepts which would provide the warfighter/team increased situational awareness for operations in an urban environment.<br><br>*FY 2010 Accomplishments:*<br>-  Initiated trade studies of vehicle designs, propulsion systems, flight dynamics and control, ground mobility, energy conversion and storage, vehicle architecture, and stowable wing structures.<br>-  Initiated conceptual design of the operational vehicle and the system requirements of a demonstration prototype vehicle.<br><br>*FY 2011 Plans:*<br>-  Continue detailed trade studies to develop a vehicle design in areas including propulsion, adaptable wing structures, lightweight materials, advanced flight control system, air/ground configuration designs, and energy storage and distribution.<br>-  Develop a detailed technology maturation plan that provides an integrated risk reduction strategy and achieves the ground and flight test goals of the demonstration prototype vehicle. | 6.000 | 12.200 | 16.000 |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Continue development of a conceptual design of the operational vehicle and the system requirements of a demonstration prototype vehicle.<br>- Conduct technology interchange meetings to develop integration plan for vehicle critical enabling technologies.<br><br>*FY 2012 Plans:*<br>- Conduct preliminary design review of TX prototype vehicle concepts to examine the prototype vehicle solutions in higher detail and the detailed program plans and cost for the remaining phases.<br>- Integrate critical enabling technology development efforts into overall vehicle development.<br>- Conduct component testing to show feasibility and function of key technology components.<br>- Initiate risk reduction experiments and modeling to validate design performance. | | | |
| *Title:* Mission Adaptive Rotor (MAR)<br><br>*Description:* The goal of the Mission Adaptive Rotor (MAR) program is to develop and demonstrate the capability to achieve dramatic improvements in rotor performance, survivability, and availability through the use of technologies that enable adaptation of the rotor throughout military missions and/or mission segments. Recent research indicates that significant performance benefits could be achieved by actively morphing the shape or properties of the rotor system; additionally, active rotors with on-blade control could eliminate the need for a rotor swashplate. MAR capability will result in dramatic improvements in system performance, operational availability, sustainability, and survivability, including reduction in acoustic susceptibility and rotor vibration while increasing useful payload fraction and range.<br><br>The MAR program will mature active rotor technologies that enable the effective operation of military rotorcraft in performance-limited environments of high-altitude mountainous terrain and deserts. The MAR program will also focus on development of advanced technologies for application to future helicopter, tiltrotor, and other rotorcraft platforms, with demonstration on a fielded system to enable application to new systems as well as facilitate upgrade of current multi-service rotorcraft systems.<br><br>*FY 2010 Accomplishments:*<br>- Initiated conceptual designs of the MAR demonstration system.<br>- Conducted evaluations of adaptive rotor technologies.<br><br>*FY 2011 Plans:*<br>- Define quantitative results of design trade studies and risk mitigation assessments.<br>- Initiate preliminary design of the MAR demonstration rotor system.<br>- Conduct principal investigators meeting for joint-Service and industry collaboration to identify critical enablers (tools, test facilities, specification revisions, etc) for successful adaptive rotor development and deployment. | 8.596 | 12.792 | 5.042 |

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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | R-1 ITEM NOMENCLATURE<br>PE 0602702E: *TACTICAL TECHNOLOGY* | PROJECT<br>TT-07: *AERONAUTICS TECHNOLOGY* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Define a rotor system design for technology demonstration.<br>- Complete objective system application development.<br>- Complete technology maturation plan for the MAR rotor system.<br>- Complete systems requirement review for the MAR demonstration rotor system.<br><br>*FY 2012 Plans:*<br>- Conduct preliminary design review of the MAR demonstration rotor system.<br>- Conduct major component tests and demonstrations to mature active rotor technologies.<br>- Initiate planning for ground testing of MAR demonstration rotor system. | | | |
| *Title:* Advanced Aeronautic Technologies<br><br>*Description:* The Advanced Aeronautics Technologies program will examine and evaluate aeronautic technologies and concepts through applied research. These may include feasibility studies of novel or emergent materials, devices and tactics for air vehicle applications, as well as manufacturing and implementation approaches. The areas of interest range from propulsion to control techniques to solutions for aeronautic mission requirements. The result of these studies may lead to the design, development and improvement of prototypes.<br><br>*FY 2011 Plans:*<br>- Conduct feasibility and trade studies of candidate technologies and architectures.<br>- Perform military utility analyses of proposed tactics and concepts of operation.<br><br>*FY 2012 Plans:*<br>- Perform modeling of concepts and architectures.<br>- Conduct enabling technology and sub-system feasibility experiments. | - | 2.000 | 2.000 |
| *Title:* Formation Flight<br><br>*Description:* The Formation Flight program is exploring the development of drag reduction technologies for aircraft. Drag reduction allows aircraft to fly at increased ranges, reduces fuel consumption, and may allow increased payload capacity. Formation flight is used in nature by geese and other migratory birds to reduce drag, but requires the development of an autonomous system to maintain the optimum position for drag reduction to be practical for long duration aircraft flights. Safety of flight considerations require aircraft separation distances of up to one mile, necessitating automated sensing and tracking algorithms to track the lead aircraft wake. Flight testing a formation flight configuration will allow structural excitation and vehicle dynamic response to be addressed in proximity to the lead aircraft wake.<br><br>*FY 2010 Accomplishments:* | 8.000 | 7.700 | - |

| Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency | | **DATE:** February 2011 |
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| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-07: *AERONAUTICS TECHNOLOGY* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Began detailed flight test planning for assessment of autopilot faults, alarms, and structural response of the aircraft wing in proximity to the aircraft wake.<br>- Started detailed stability and control law assessments for aircraft-wake interactions and trim effects.<br>- Initiated evaluation of existing database of wake crossings to determine impacts on flight control systems.<br><br>*FY 2011 Plans:*<br>- Complete detailed flight test planning for assessment of autopilot faults, alarms, and structural response of the aircraft wing in proximity to the aircraft wake.<br>- Complete detailed stability and control law assessments for aircraft-wake interactions and trim effects.<br>- Complete evaluation of existing database of wake crossings to determine impacts on flight control systems. | | | |
| *Title:* Helicopter Quieting<br><br>*Description:* The goal of the Helicopter Quieting program was to advance the capability for analytical development of advanced rotor technologies to dramatically enhance the survivability of military rotor systems while enabling improvements to performance, affordability, availability and suitability.  A critical element toward this goal was the creation and demonstration of a physics-based toolset to enable analytical design of novel rotor systems and rotorcraft for reduced acoustic susceptibility (detection and recognition) by human and electro-acoustic threats.  Novel and creative concepts and ideas were employed in this program for accurate aerodynamic analysis of helicopter rotor airloading, flowfield, and wakes using high-end computational fluid dynamics techniques.  The program developed tools capable of accurately predicting noise signature of advanced rotor concepts that exhibit a significant reduction in low-frequency in-plane signatures.<br><br>*FY 2010 Accomplishments:*<br>- Identified acoustic design criteria for new rotor system designs based on operational scenarios.<br>- Transitioned tools to Services, industry, and academia. | 1.819 | - | - |
| *Title:* Nano Air Vehicle (NAV)<br><br>*Description:* The goal of the Nano Air Vehicle (NAV) program was to develop a hummingbird-inspired flapping air vehicle technology with less than a five inch wingspan and gross take-off weight of fifteen grams or less.  Operations in the urban terrain require sensors that can navigate in difficult terrain and be inserted without being detected.  Small air vehicles capable of navigating interior domains without GPS would enable autonomous prosecution of a number of high risk missions that are currently performed by warfighters.  Examples of such missions include intelligence, surveillance and reconnaissance (ISR) in buildings, underground facilities, caves, tunnels, and confined urban environments.  Key enabling technologies included: flapping wing aerodynamics, kinematics and flight dynamics, lightweight aero-elastically tailored wing structures, miniature navigation systems, micro-propulsion systems, small payloads, and the ability to perch like a bird. | 2.500 | - | - |

| **Exhibit R-2A**, **RDT&E Project Justification:** PB 2012 Defense Advanced Research Projects Agency | | **DATE:** February 2011 |
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| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-07: *AERONAUTICS TECHNOLOGY* |

| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012** |
|---|---|---|---|
| *FY 2010 Accomplishments:*<br>-  Demonstrated mission-relevant flight times of >5 minutes hovering and >10 minute forward flight.<br>-  Developed preliminary user controller and onboard vehicle navigation system to permit robust remote-controlled flight.<br>-  Demonstrated prototype vehicle outfitted with video cameras in mock missions relaying video to the vehicle operator. | | | |
| **Accomplishments/Planned Programs Subtotals** | 26.915 | 34.692 | 23.042 |

**C. Other Program Funding Summary ($ in Millions)**

   N/A

**D. Acquisition Strategy**

   N/A

**E. Performance Metrics**

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

| Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency | | DATE: February 2011 |
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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | R-1 ITEM NOMENCLATURE<br>PE 0602702E: *TACTICAL TECHNOLOGY* | PROJECT<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |
|---|---|---|

| COST ($ in Millions) | FY 2010 | FY 2011 | FY 2012 Base | FY 2012 OCO | FY 2012 Total | FY 2013 | FY 2014 | FY 2015 | FY 2016 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* | 65.904 | 58.139 | 48.910 | - | 48.910 | 44.281 | 43.697 | 43.724 | 39.724 | Continuing | Continuing |

## A. Mission Description and Budget Item Justification

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

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 while enabling 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.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| *Title:* Video and Image Retrieval and Analysis Tool (VIRAT)<br><br>*Description:* The Video and Image Retrieval and Analysis Tool (VIRAT) program will develop and demonstrate a system for video data exploitation that enables an analyst to rapidly find video content of interest from archives and provides alerts to the analyst of events of interest during live operations. The ability to quickly search large volumes of existing video data and monitor real-time video data for specific activities or events will provide a new capability to the U.S. military and intelligence agencies. Currently, video analysis is very labor intensive, limited to metadata queries, manual annotations, and "fast-forward" examination of clips. The software tools developed under VIRAT will radically improve the analysis of huge volumes of video data by: 1) alerting operators when specific events or activities occur at specific locations or over a range of locations and; 2) enabling fast, content-based searches of existing video archives. The final product of the VIRAT program is a system that can be transitioned to and integrated within an operational military system, such as the Distributed Common Ground System (DCGS).<br><br>*FY 2010 Accomplishments:* | 15.159 | 13.716 | 13.021 |

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| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Developed technologies for efficient indexing and interactive retrieval against multiple activities.<br>- Designed an interactive retrieval process to incorporate improved algorithms and enhanced human factors.<br>- Ensured activity descriptor extraction technologies exhibit acceptable performance across multiple airborne video sources.<br><br>*FY 2011 Plans:*<br>- Develop technologies to accommodate stationary, ground-mounted video sources.<br>- Add geo-registration capability to support operational use of the data.<br>- Continue developing efficient indexing and interactive retrieval against a larger set of activities.<br><br>*FY 2012 Plans:*<br>- Complete development and optimization of technologies to accommodate larger datasets.<br>- Integrate final prototype system in accordance with the architecture of the program of record transition target.<br>- Test and evaluate performance of the system against an experienced analyst's performance. | | | |
| *Title:* Integrated Crisis Early Warning System (ICEWS)<br><br>*Description:* The Integrated Crisis Early Warning System (ICEWS) program develops and integrates a set of data analysis tools into a unified information system to support Theater Security Cooperation (TSC).  The ICEWS system monitors, assesses and forecasts leading indicators of events that make countries vulnerable to crises.  ICEWS technologies include quantitative and computational social science modeling and simulation, scenario generation, ontological modeling of security problems, advanced interactive visualization techniques, and agent-based programming.  ICEWS will also develop a collaborative, open-source testbed that will facilitate the integration and evaluation of alternative, operationally relevant social theories.  Natural language processing is required to identify and extract information that is predictive from text and speech-based media and to distill that information into a form that is actionable by civilian and military leadership.  ICEWS will develop a large body of test cases (source data and outcomes) against which the social science theories can be evaluated.  When integrated, these tools will allow combatant commanders and their staff to understand and anticipate conditions that precipitate instability and conflict while there is still time to influence them.  ICEWS will also help commanders anticipate unintended consequences of actions taken to influence or remediate situations, consequences that may be delayed by months or years.<br><br>*FY 2010 Accomplishments:*<br>- Applied the ICEWS data extraction and analysis methodologies in PACOM Terminal Fury exercise.<br>- Began generating and evaluating monthly forecasts of events of interest in the PACOM Area of Responsibility (AOR) and transitioned system components to PACOM.<br>- Developed a prototype system to explore how changes in leading indicators of events of interest can enable mitigating crises in the AOR. | 10.195 | 8.705 | 5.284 |

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| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |

| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012** |
|---|---|---|---|
| - Developed and applied initial social network models as a means for understanding groups of individuals connected through shared interests and collaborative activities.<br><br>*FY 2011 Plans:*<br>- Test the ICEWS forecasting algorithms against intelligence analysts' judgment at PACOM and deploy additional ICEWS components to PACOM for test and evaluation.<br>- Extend the ICEWS data extraction and analysis methodologies to additional combatant commands.<br>- Integrate new unclassified data feeds from the Open Source Center into ICEWS.<br>- Experiment with different methodologies to extract more accurate real time event data and other indices important for crisis forecasting.<br>- Develop and apply methods to detect, characterize, and predict the dynamics of social networks from complex, conflicting, and incomplete data sets.<br><br>*FY 2012 Plans:*<br>- Implement a testbed and develop associated datasets as a platform for integrating and evaluating social science theories.<br>- Extend testbed platform to address operationally-relevant questions from multiple problem classes and demonstrate the capability to formalize and integrate theories proposed by others.<br>- Test and evaluate social science theories across a rich set of retrospective and prospective testbed data and quantify the anticipated strengths and weaknesses of alternative approaches.<br>- Integrate classified data feeds into ICEWS.<br>- Test, evaluate, and transition ICEWS components to combatant commands as they mature. | | | |
| *Title:* Nexus 7*<br><br>*Description:* *Previously funded in Production of Knowledge Bases to Bridge Cultural Divides in PE 0601101E, Project TRS-01<br><br>The Nexus 7 program is applying  the forecasting, data extraction, and analysis methodologies developed in ICEWS to develop tools, techniques, and frameworks for the automated interpretation, quantitative analysis, and visualization of social networks. Social network theory has emerged in recent years as a promising approach for understanding groups of individuals connected through a variety of shared interests and collaborative activities.  For the military, social networks provide a promising model for terrorist cells, insurgent groups, and other stateless actors whose connectedness is established not on the basis of shared geography but rather through the correlation of their participation in coordinated activities such as planning meetings, training/ mission rehearsal sessions, sharing of materiel/funds transfers, etc.  The Nexus 7 program will develop and apply emerging methods for edge finding and cluster analysis to detect, characterize, and predict the dynamics of social networks.  The resulting capabilities have important application in tactical contexts to aid analysts and operators in connecting the dots amid | - | - | 30.605 |

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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | R-1 ITEM NOMENCLATURE<br>PE 0602702E: *TACTICAL TECHNOLOGY* | PROJECT<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| complex, conflicting, and incomplete data sets.  They also establish a foundation for cultural intelligence - understanding the stability, governance, and economic indicators of a region - and the capability to better focus stability, security, transition, and reconstruction operations on high-payoff initiatives.<br><br>*FY 2012 Plans:*<br>-  Develop techniques for simulation, visualization, inference, and prediction of social network dynamics.<br>-  Develop techniques for modeling the interactions between and within cooperating/competing/conflicting social networks, sub-networks, and super-networks and for predicting the merging and splitting of social networks.<br>-  Evaluate tools and techniques on real-world social-cultural-network data. | | | |
| *Title:* Extreme Accuracy Tasked Ordnance (EXACTO)<br><br>*Description:* The objective of the Extreme Accuracy Tasked Ordnance (EXACTO) program is to revolutionize the Service sniper's ability to engage targets at long range, regardless of target motion or crosswinds, with previously unachievable accuracy.  The EXACTO system is comprised of an advanced targeting optic, the first ever guided small caliber bullet, innovative guidance and control software, and a conventional sniper rifle.  The EXACTO 50-caliber bullet and optical sighting technology will greatly extend the day and night ranges over current state-of-the-art sniper systems allowing sniper teams to engage tactically important moving (or accelerating) targets in high crosswind conditions such as those commonly found in Afghanistan.  Current technology is extremely limited in its ability to compensate for high crosswinds, significant target motion, or target acceleration.  EXACTO will not only dramatically improve sniper effectiveness, but also enhance troop safety by allowing greater shooter standoff range and reduce target engagement timelines.  The EXACTO system combines a command guided bullet with a guidance control system capable of compensating for adverse environmental conditions and tracking mobile targets in real-time.  The technology development plan includes risk reduction and system integration of all system components and will culminate in live fire testing of a prototype EXACTO system at a full spectrum of ranges, day/night, and environmental conditions, to fully validate system performance.<br><br>*FY 2010 Accomplishments:*<br>-  Performed component testing, performance modeling, and explored system integration opportunities for all subsystems.<br>-  Validated critical sub-system component performance including optical link, electronics packaging, bearings survivability, and turbulence mitigation for target optic.<br>-  Successfully demonstrated potential system performance of two competing EXACTO designs through  detailed simulation based on established component and subsystem performance data, featuring integrated hardware components, and a comprehensive Monte Carlo simulation executed at numerous simulated ranges and environmental and target conditions. | 16.889 | 22.218 | - |

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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | R-1 ITEM NOMENCLATURE<br>PE 0602702E: *TACTICAL TECHNOLOGY* | PROJECT<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Developed program plans and a preliminary design for prototype EXACTO system live fire demonstration.<br><br>*FY 2011 Plans:*<br>- Revise component, software, and prototype system design as necessary to optimize performance.<br>- Continue risk reduction simulation and testing of EXACTO system, component hardware and software.<br>- Perform initial bullet packaging demonstration.<br>- Develop detailed design and begin fabrication of EXACTO prototype system and bullets.<br>- Validate critical integrated sub-systems and performance models with software-in-the-loop simulations.<br>- Complete fabrication of EXACTO prototype system and bullets.<br>- Validate EXACTO system performance by incrementally demonstrating key system functionality.<br>- Conduct live fire performance demonstration of prototype system over full scope of target ranges, velocities, and environmental conditions. | | | |
| *Title:* PERsistent Stare Exploitation and Analysis System (PerSEAS)<br><br>*Description:* The PERsistent Stare Exploitation and Analysis System (PerSEAS) program will develop and demonstrate a tool to automatically and interactively identify activity-based events of interest from persistent, wide area, motion imagery data with support from signals intelligence and other sources.  Persistent, wide area surveillance imagery is an ever increasing source of operational data, but exploitation of this data at present is mostly manual and requires hours to days to produce results.  Tools are needed to automatically detect potentially significant adversary activities and to discriminate these from nominal background activity.  These tools would be supported by libraries of activity patterns, logic to generate hypotheses about which activities are being observed, and mechanisms to quantitatively score the consistency of the data with each activity hypothesis.  Such capabilities are necessary to detect and defeat threats in real-time.  The major thrust of the program is the hierarchical processing of extracted features (such as context and tracks) to yield events of interest, which in turn would be linked to form activities and then integrated to discover and infer potential threat patterns.  The discovery and identification of the potential threat patterns would then produce alerts and cues for analysts to interactively adjudicate and validate.  PerSEAS technologies and system are planned for transition to the Distributed Common Ground System and other intelligence applications.<br><br>*FY 2010 Accomplishments:*<br>- Formulated approaches to network discovery based on normalcy estimates, improved tracking algorithms using pattern analysis, and contextual analysis for anomaly detection.<br><br>*FY 2011 Plans:*<br>- Implement and evaluate techniques on wide area motion imagery data.<br>- Develop a system prototype. | 7.500 | 9.000 | - |

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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2010 | FY 2011 | FY 2012 |
|---|---|---|---|
| - Refine and improve modeling techniques for normalcy modeling and anomaly detection.<br>- Refine and improve inferencing algorithms to recognize complex chains of activities and events.<br>- Incrementally transition algorithms or subcomponents. | | | |
| *Title:* Home Field<br><br>*Description:* The Home Field program develops networked video and Laser Detection and Ranging (LADAR) processing technology to rapidly and reliably update a 3-D model of an urban area.  It provides 3-D situational awareness with sufficient detail and accuracy to remove the "home field advantage" enjoyed by opponents.  Detailed mobility maps to support ground vehicle routing will be inferred and generated, and detailed visibility data to support sensor positioning will then be derived to maximize coverage and minimize detectability.  High fidelity baselines will be created to support change detection to cue searches for targets and anticipate changes due to current or impending meteorological events.  The program will supply real-time context information to sensor managers, maneuver controllers, weapons operators, and commanders.  Furthermore, the program will filter natural change from artificial change indicative of human (threat) activity and permit operation of military forces in hostile terrain normally deemed favorable to opponents because of their historical familiarity with hide points, sight lines, and mobility characteristics.<br><br>Drawing upon technologies developed in the Home Field program, the Urban Photonic Sandtable Display (UPSD) program has developed revolutionary interactive holographic displays for complex volumetric 3-D data to replace current 3-D visualization technologies that are either static or have limited effective field-of-view.  Current technologies include traditional holography, computer graphics on 2-D screens, slice stacking, parallax autostereo, and goggles/glasses.  These techniques not only give a poor image quality and poor movement, they also are not created quickly and do not allow for collaborative viewer interaction.  The desire to improve these components launched the development of the UPSD.  Applying the design fundamentals of the monochrome active grouping of pixels for a light modulator element into a single 3-D holographic pixel (hogel-based proof-of-concept) display and further developed module, a scalable and tileable laboratory prototype has been validated by transforming computer data to optical data, making sophisticated integration possible to optimize image quality.  The UPSD program developed an affordable 3-D display that operates at full video rate, displays red-green-blue (RGB) color, increases viewing angle, and increases display size.  The result will be the world's first full-motion, full aspect 3-D imaging technology system.  The emissive micro displays effort will develop technologies to support the fabrication of Low-cost High pixel density Power efficient Direct emission Microdisplays (LHPDM).  Current microdisplay systems use light modulation systems (liquid crystal displays, digital micromirror devices,) and by using LHPDM, it will enable the transmission of larger fractions of light from the illumination source.<br><br>*FY 2010 Accomplishments:*<br>- Demonstrated assembled monochrome and RGB 9-title hogel displays. | 16.161 | 4.500 | - |

| **Exhibit R-2A**, **RDT&E Project Justification:** PB 2012 Defense Advanced Research Projects Agency | | **DATE:** February 2011 |
|---|---|---|
| **APPROPRIATION/BUDGET ACTIVITY**<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 2: *Applied Research* | **R-1 ITEM NOMENCLATURE**<br>PE 0602702E: *TACTICAL TECHNOLOGY* | **PROJECT**<br>TT-13: *NETWORK CENTRIC ENABLING TECHNOLOGY* |

| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2010** | **FY 2011** | **FY 2012** |
|---|---|---|---|
| - Completed development of UPSD hogel display titles.<br>- Developed and demonstrated techniques for layer doping of heterostructure materials.<br>- Evaluated and selected approaches for the development of affordable emissive microdisplays.<br>- Demonstrated 32K pixel IR micro-emitter array.<br>- Selected fabrication technologies with five times cost reduction potential.<br>- Commenced demonstration of fabrication technologies that support the fabrication of affordable emissive microdisplays.<br>- Transitioned the UPSD technology to the Air Force and Army.<br><br>*FY 2011 Plans:*<br>- Complete demonstration of fabrication technologies that support affordable emissive microdisplays.<br>- Demonstrate red-green-blue capability for emissive micro displays.<br>- Demonstrate UV micro-emitter array.<br>- Complete development and fabrication of all emissive micro display modules. | | | |
| **Accomplishments/Planned Programs Subtotals** | 65.904 | 58.139 | 48.910 |

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

**D. Acquisition Strategy**
  N/A

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