| Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Defense Advanced Research Projects Agency | | | | | | | | | | DATE: February 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | | | | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | | | | | | | |
| **COST ($ in Millions)** | **FY 2009 Actual** | **FY 2010 Estimate** | **FY 2011 Base Estimate** | **FY 2011 OCO Estimate** | **FY 2011 Total Estimate** | **FY 2012 Estimate** | **FY 2013 Estimate** | **FY 2014 Estimate** | **FY 2015 Estimate** | **Cost To Complete** | **Total Cost** |
| Total Program Element | 182.583 | 222.866 | 205.032 | 0.000 | 205.032 | 251.805 | 251.131 | 242.589 | 252.392 | Continuing | Continuing |
| SEN-01: *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY* | 63.703 | 50.619 | 42.286 | 0.000 | 42.286 | 49.658 | 64.231 | 64.123 | 64.404 | Continuing | Continuing |
| SEN-02: *SENSORS AND PROCESSING SYSTEMS* | 118.880 | 99.486 | 82.541 | 0.000 | 82.541 | 87.179 | 87.211 | 90.095 | 92.986 | Continuing | Continuing |
| SEN-03: *EXPLOITATION SYSTEMS* | 0.000 | 33.455 | 51.807 | 0.000 | 51.807 | 68.148 | 61.407 | 59.407 | 56.013 | Continuing | Continuing |
| SEN-CLS: *Classified* | 0.000 | 39.306 | 28.398 | 0.000 | 28.398 | 46.820 | 38.282 | 28.964 | 38.989 | Continuing | Continuing |

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

(U) The Sensors Technology program element is budgeted in the Advanced Technology Development Budget Activity because it funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability and battle damage assessment.

(U) The Surveillance and Countermeasures Technology project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing and low-cost microelectronics to develop advanced surveillance and targeting systems. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with tactical information needed to succeed in future wars. Additionally, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.

(U) The Sensors and Processing Systems project develops and demonstrates advanced sensors, and exploitation technologies. These efforts provide warfighters with situational awareness and precision target identification. The project is driven by four needs: 1) integrating data from multipath sources into consistent situational assessments; 2) providing near-real-time, semi-automatic exploitation of wide-area moderate and high-resolution imagery; 3) obtaining real-time, accurate battle damage assessment; and 4) accomplishing robust, precise identification, precision fire control tracking and engagement of ground targets.

(U) The Exploitation Systems project develops algorithms, software, and information processing systems to extract information from massive intelligence, surveillance, and reconnaissance (ISR) datasets. In particular, it develops new technologies for detection and discrimination of targets from clutter, classification and fingerprinting of high value targets, localization and tracking over wide areas, and threat network identification and analysis.

| Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Defense Advanced Research Projects Agency | DATE: February 2010 |
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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* |

**B. Program Change Summary ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Previous President's Budget | 214.582 | 243.056 | 0.000 | 0.000 | 0.000 |
| Current President's Budget | 182.583 | 222.866 | 205.032 | 0.000 | 205.032 |
| Total Adjustments | -31.999 | -20.190 | 205.032 | 0.000 | 205.032 |
| • Congressional General Reductions | | -0.934 | | | |
| • Congressional Directed Reductions | | -19.256 | | | |
| • Congressional Rescissions | -1.044 | 0.000 | | | |
| • Congressional Adds | | 0.000 | | | |
| • Congressional Directed Transfers | | 0.000 | | | |
| • Reprogrammings | -24.926 | 0.000 | | | |
| • SBIR/STTR Transfer | -6.029 | 0.000 | | | |
| • TotalOtherAdjustments | 0.000 | 0.000 | 205.032 | 0.000 | 205.032 |

**Change Summary Explanation**

FY 2009

Decrease reflects Section 8042 rescission of the FY 2010 Appropriations Act, Omnibus Reprogramming action for the H1N1 vaccine development, SBIR/STTR transfer and internal below threshold reprogramming.

FY 2010

Decrease reflects reductions for the Section 8097 Economic Assumption, execution delays and FY 2010 new starts.

FY 2011

Not Applicable

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | | DATE: February 2010 |
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| COST ($ in Millions) | FY 2009 Actual | FY 2010 Estimate | FY 2011 Base Estimate | FY 2011 OCO Estimate | FY 2011 Total Estimate | FY 2012 Estimate | FY 2013 Estimate | FY 2014 Estimate | FY 2015 Estimate | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEN-01: *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY* | 63.703 | 50.619 | 42.286 | 0.000 | 42.286 | 49.658 | 64.231 | 64.123 | 64.404 | Continuing | Continuing |

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

(U) This project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability, and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a clandestine manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. In addition, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Low-Altitude Airborne Sensor System (LAASS) | 12.226 | 3.490 | 5.559 | 0.000 | 5.559 |
| (U) The Low-Altitude Airborne Sensor System (LAASS) program is developing an airborne sensor system to find and characterize underground facilities (UGFs) used to shield and protect strategic and tactical activities, including command and control, weapons storage, and manufacture of weapons of mass destruction (WMD) and tunnel networks that breach secure borders and perimeters. By passively capturing emissions associated with underground facility presence and operations, and doing so using airborne sensors (acoustic, electromagnetic, gravity gradiometry), LAASS can significantly increase our ability to seek out underground facilities and map out their vulnerabilities and backbone structure. LAASS technologies are planned to transition to Northern Command, Southern Command, Strategic Command, or Defense Threat Reduction Agency in FY 2013. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2009 Accomplishments:*<br>- Completed gravity gradiometry system requirements for tactically useful tunnel detection capability.<br>- Completed evaluation of candidate sensor technologies for development of gravity gradiometer prototype evaluation system.<br>- Produced system design and initiated development of gravity gradiometer prototype evaluation system.<br><br>*FY 2010 Plans:*<br>- Develop algorithm concepts and operational CONOPS for the confident detection of tunnels in the presence of geologic clutter, defined as natural structures that have properties similar to tunnels.<br>- Explore the potential of alternative technologies to mitigate geologic clutter and reduce false alarms.<br>- Complete development of gravity gradiometry sensor suite and perform major system design trades.<br><br>*FY 2011 Base Plans:*<br>- Validate, through modeling and laboratory tests, that existing gravity gradiometry sensor technologies and all supporting subsystems can be successfully adapted to meet Gravity Anomaly for Tunnel Exposure (GATE) system requirements and detection performance.<br>- Document expected performance of system concept (sensor, installation, processing).<br>- Develop high-risk, critical-path components (e.g. sensor and sensor isolation).<br>- Validate that high-risk components can be fabricated which meet required system specifications for detection performance.<br>- Generate system design (preliminary and critical) for capability on tactical platform.<br>- Develop prototype payload and integrate onto a tactical air vehicle. | | | | | |
| Airborne Tomography using Active Electromagnetics (ATAEM)<br><br>(U) The Airborne Tomography using Active Electromagnetics (ATAEM) program is developing an active electromagnetic (EM) system for airborne imaging of subsurface structures, such as underground facilities (UGFs) or perimeter-breaching tunnels. The ATAEM system illuminates the ground with | 6.136 | 6.971 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| electromagnetic energy and interprets resulting distortions of the electric and magnetic fields to detect and characterize surreptitious structures. The ATAEM program will investigate and develop the component technologies, including EM illumination sources, noise-isolated sensor payloads and signal processing. ATAEM developed technology is expected to be available for transition to the U.S. Army, U.S. Marine Corps, and U.S. Special Operations Command in FY 2010.<br><br>*FY 2009 Accomplishments:*<br>- Integrated low-noise sensor suite into helicopter tow pod.<br>- Investigated and developed off-board electromagnetic illumination sources.<br>- Completed testbed development and integration, and documented system specifications.<br>- Collected and analyzed operationally relevant airborne data over multiple targets of interest as a function of operational parameters (illumination sources, flight parameters).<br>- Identified and documented deficiencies in the system concept for EM sources and sensor payload noise floor that impacted realizable testbed performance.<br><br>*FY 2010 Plans:*<br>- Expand and evaluate range of technologies and signatures through modeling and focused field collections to establish feasibility for close-access missions such as tactical tunnel detection.<br>- Develop an integrated system model for predicting the performance of alternative system concepts supported by field measurements.<br>- Develop mitigation strategy using multiple technologies to negate false detections caused by geologic clutter.<br>- Develop system requirements for multiple technology concept. | | | | | |
| Strategically Hardened Facility Defeat<br><br>(U) Building upon the successes of technology developed under the Counter Underground Facilities program, the Strategically Hardened Facility Defeat program will continue to develop alternative earth-penetrating technologies for the defeat of strategically hardened targets. The threat posed by the | 12.404 | 7.481 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| proliferation of hard and deeply buried targets with major strategic capabilities around the world is increasing dramatically. These strategically hardened facilities are used to harbor our adversaries' most dangerous assets including leadership bunkers, command and control functions, and weapons of mass destruction. However, because the size and weight of traditional earth penetrating weapons scale exponentially with the depth of the facility, current warhead penetration depths are and always will be insufficient to reach many of these targets. As a result, a strategic capability gap exists and new approaches to earth penetration and warhead delivery are needed. This program leverages recent advances in earth-penetrating technologies for full defeat of strategically hardened facilities at depths inaccessible to traditional earth penetrating weapons. Technology developed under this program will be available for transition to the Defense Threat Reduction Agency (DTRA) in FY 2010.<br><br>*FY 2009 Accomplishments:*<br>- Integrated advanced penetration and energy supply technologies.<br>- Demonstrated penetration, energy and deployment capabilities through field trials.<br>- Developed sensing and navigation capabilities.<br><br>*FY 2010 Plans:*<br>- Design and initiate development of deployable system with advanced penetration and navigation capabilities. | | | | | |
| Lightning Based (Sferic) Underground Geo-positioning<br><br>(U) The Lightning Based (Sferic) Underground Geo-positioning program will address the challenges presented when navigating and tracking within underground structures, both manmade and natural, by exploiting the abundance and long propagation range of naturally occurring global lightning events. As conceived, surface receivers at known locations will compare time difference of arrival of very low frequency (VLF) sferic events and employ super-resolution correlation techniques to accurately determine the VLF source locations. Any subsurface receiver will also detect the sferics, and real time or post-mission correlation with the surface data will enable geo-location of the subsurface receiver. | 2.000 | 8.256 | 6.543 | 0.000 | 6.543 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Exploitation of naturally-occurring, nondeniable signals has the potential to significantly reduce logistical requirements and increase operational standoff by orders of magnitude (1000+ km). Transition to U.S. Special Operations Command (SOCOM) and the U.S. Army is anticipated by FY 2012.<br><br>*FY 2009 Accomplishments:*<br>- Acquired global signal availability data as function of geographic coordinates and time, for determination of operational constraints on sferics-based navigation.<br>- Conducted field tests to determine geolocation accuracy with varying geologic overburdens.<br>- Revised and validated models for propagation of sferics over long distances (100s to 1000s of km) to support mission planning and performance prediction.<br><br>*FY 2010 Plans:*<br>- Develop and demonstrate non-real time geolocation of an underground user in the field.<br>- Develop and demonstrate through-the-earth (TTE) communications for navigation (surface-to-subsurface communications) and tracking (subsurface-to-surface communications) scenarios.<br>- Design prototype hardware for subsurface receivers and processors and TTE communications.<br>- Evaluate potential for integration of global lightning receiver network data into the sferic system.<br><br>*FY 2011 Base Plans:*<br>- Demonstrate above ground to below ground TTE communications for navigation (surface-to-subsurface communications) and scenarios.<br>- Build and test prototype hardware (receiver and processors) for sferic-based geopositioning and navigation. | | | | | |
| Visibuilding<br><br>(U) The Visibuilding program is developing technologies and systems for new building surveillance capabilities to detect personnel within buildings, determine building layouts, and locate weapons caches within buildings. This program is developing techniques to inject and recover probing radar | 15.970 | 20.271 | 11.184 | 0.000 | 11.184 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| waveforms and unravel the complicated multipath in the return signals to enable the mapping and characterization of building interiors. Radar signals are being used to image static structures directly. Doppler processing of radar signals is also being exploited to find, identify, and perform feature-aided tracking of moving personnel within a building and allow mapping of building pathways and stairways by monitoring traffic through buildings. Multipath and propagation effects are modeled and iteratively compared with hypotheses of building structures to provide 3-D building maps and large concentrations of metal materials like weapons. Other sensing modalities and component technologies are concurrently being investigated that offer the possibility of providing complementary information about the layout of large buildings as well as their associated underground areas. Component pieces will transition to the Army's Program Executive Office (PEO) Intelligence, Electronic Warfare & Sensors (IEWS) and U.S. Special Operations Command.<br><br>*FY 2009 Accomplishments:*<br>- Designed and built fieldable instrumentation radar systems for collection from airborne, vehicle, and emplaced platforms.<br>- Performed developmental and blind test collection on two-story, unfurnished buildings and quantified system floor plan reconstruction and insurgent localization.<br>- Began investigation of alternative sensing technologies for interior layout and associated underground structures.<br><br>*FY 2010 Plans:*<br>- Develop system design for a radar-based system to meet metric for determining floor plan and insurgent tracks within 30 minutes.<br>- Develop radar design and processing techniques to mitigate radar clutter experienced in realistic urban environments (e.g. from furniture).<br>- Develop and model performance of multiple alternative sensing approaches. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2011 Base Plans:*<br>- Complete demonstrations of radar-based prototype system and quantify ability to determine building layout and track insurgents within furnished multi-story buildings.<br>- Complete and evaluate concept development for ability of alternative sensing modalities to contribute to above-ground and below-ground layout.<br>- Identify validated alternative sensing modalities for continued development.<br>- Transition radar-based system to U.S. Army and U.S. Special Operations Command. | | | | | |
| Rescue Transponder (RT) | 2.217 | 2.150 | 0.000 | 0.000 | 0.000 |
| (U) Building upon technologies developed in other sensor programs, the Rescue Transponder (RT) program will investigate the use of a unique localization and tracking technology to provide a very low probability of detection (LPD) call for help signal. The system will use a wide band radio frequency signal with low power and extremely low duty cycle. The goals of the RT program are to develop a small, rugged transponder that provides a call for help to friendly forces. The RT system will operate over ranges that enable rescue forces or surveillance systems to receive its signals. It will support accurate localization by rescue forces, and permit transmission of identifying, authenticating, and status information. The RT technology is planned for transition to the U.S. Marine Corps in 2010.<br><br>*FY 2009 Accomplishments:*<br>- Evaluated deployable unit performance in U.S. Marine Corps EXERCISE Talisman Saber 2009.<br>- Developed and conducted field experiments in support of U.S. Marine Corps initial end-user field evaluations.<br>- Researched enhancements to support system performance capabilities for military use.<br>- Initiated design of enhanced version of RT to allow improved calibration and synchronization.<br><br>*FY 2010 Plans:*<br>- Develop advanced prototypes with self-calibration and non-synchronization tag capabilities to simplify operations. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Develop and conduct field experiments to support major U.S. Marine Corps operational field exercise.<br>- Complete transition between DARPA and U.S. Marine Corps. | | | | | |
| Combat Laser Infrared Countermeasure (IRCM) Proactive Survivability System (CLIPSS) | 3.000 | 2.000 | 2.000 | 0.000 | 2.000 |
| (U) The Combat Laser Infrared Countermeasure (IRCM) Proactive Survivability System (CLIPSS) will enable air dominance at low altitude and at night against infrared missile threats in the form of man portable air defense (MANPAD) systems, adjunct missile guidance systems and advanced infrared search and track systems, based on proactive infrared countermeasures (PIRCM). Leveraging the systems and focal plane array (FPA) technology development established by the Multifunction Electro-Optics for Defense of U.S. Aircraft (MEDUSA) program (budgeted in PE 0603768E, Project GT-01) in the near infrared, mid-wave infrared, and potentially the long-wave infrared bands of the optical spectrum and the reactive directed infrared countermeasures (DIRCM) capabilities currently in the field, CLIPSS will provide a near term demonstration and transition of the proactive capability and serve as a pathfinder for the longer range, all band objectives of MEDUSA. The primary technical obstacles of this approach will be the continued development and integration of high sensitivity infrared Focal Plane Array (FPA) and multi-frequency laser technologies into compact, efficient packages for demanding IRCM environments. The real-time processing of the range resolved laser returns over wide fields of view to rapidly cue the proactive countermeasures poses a significant systems integration challenge as well and will be addressed by this demonstration. CLIPSS Technology is planned to transition to the Services in FY 2014.<br><br>*FY 2009 Accomplishments:*<br>- Completed study analysis of potential system performance based on emerging sensor technology supporting the PIRCM application. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2010 Plans:*<br>- Complete the design of airborne breadboard system(s) to demonstrate proactive IRCM to support clutter rejection algorithms.<br>- Initiate design and modeling of integrated Proactive IRCM / Directed IRCM pod-based demonstration system.<br><br>*FY 2011 Base Plans:*<br>- Initiate key laser and optical technology development to support detailed design objectives.<br>- Complete key technology demonstrations to support objective system designs.<br>- Complete airborne breadboard PIRCM data collection.<br>- Validate performance modeling to support critical design for integrated pod-based PIRCM / DIRCM system. | | | | | |
| Robust Surface Navigation (RSN)<br><br>(U) The Robust Surface Navigation (RSN) program (previously funded under PE 0603768E, Project GT-01) will provide the U.S. warfighter with the ability to navigate effectively when the Global Positioning System (GPS) is unavailable due to hostile action (e.g. jamming) or blockage by structures and foliage. The RSN program will use Signals of Opportunity (SoOP) from a variety of ground, air, and space-based sources, augmented by judiciously placed RF beacons; these will be received on the Warfighter's forthcoming software defined radios and use specially tailored algorithms to determine position. The greater strength and diversity of these signals will provide coverage when GPS is denied due to environmental conditions or hostile activity. This is a two-part program: (1) cataloging and assessing potential exploitable signals followed by analysis and performance modeling and hardware-based concept validation, and; (2) designing, testing, and demonstrating a (non-form-fit) prototype receiver(s) and algorithms for geolocation using the SoOP. The RSN technology is planned for transition to the U.S. Special Operations Command and the U.S. Army with specific elements of the program transitioning to the U.S. Navy and U.S. Air Force in FY 2011. | 0.000 | 0.000 | 7.000 | 0.000 | 7.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2011 Base Plans:*<br>- Conduct field tests and demonstrate the functional RSN prototype in user-selected environments such as forested, jungle and open environments, and for airborne platforms.<br>- Transition RSN technology. | | | | | |
| Global Tactical ISR<br>(U) The Global Tactical ISR program will develop technologies to provide tactical-grade ISR with coverage scalable from the local to the global, to address issues of global importance. Our forces must conduct military operations with exquisite precision across an expansive theater of operations like the Pacific Ocean, in addition to highly specific locations such as a building in a densely populated urban area. The ISR that supports this wide range of operations needs to be correspondingly precise and accurate at rates typical of tactical operations, as well as meet salient requirements such as operate through jamming. New technologies are needed that address the demanding challenges presented by tactical-level ISR with geographic coverage extending from the extremely broad to the ultra narrow. These technologies include new signal sources for probing the environment, receivers, algorithms, and sensors in general. The program will result in fundamentally new technology approaches. For example, the application of commercial technologies to military problems often results in signature or performance compromises that need to be re-examined to enable the maximum benefit to the warfighter. Specific examples include a pulsed fiber-laser that pushes existing peak-power system limitations may be developed for rapidly deployable long-range laser radar systems, as well as a mid-IR laser sources for biological and chemical detection applications. Stand-off detection of special nuclear material at distances greater than 1 km may be enabled by a novel X-ray source. New engineering approaches to be developed by the program may include enhancing the performance of existing airborne and space-borne sensors through novel algorithms that minimize the need for costly new flight hardware. Thermal inertia imaging, and other technologies when combined with the advanced data processing may yield solutions to persistent problem sets such as underground facility detection and tunnel detection. Revolutionary new sensing modalities may enable the acquisition of new signatures | 0.000 | 0.000 | 5.000 | 0.000 | 5.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| to enhance our intelligence collection. The overriding objective of this program is the development of sensor technologies that enable ISR for local areas of operation typical of the brigade-level and below, as well as for the global and regional coverage needed by the Combatant Commands. This program plans to transition to the Services FY 2015.<br><br>*FY 2011 Base Plans:*<br>- Identify alternative concepts for revolutionary signal sources, receivers, algorithms and/or sensors for global tactical ISR.<br>- Establish proof-of-concept for global tactical ISR technologies.<br>- Initiate development of prototypes. | | | | | |
| Assured Operations in High Latitudes<br><br>(U) The Assured Operations in High Latitudes program will develop technologies to assure operations in the extreme environment typical of high latitudes, which has the challenges of ice, snow, permafrost, weather, and unique ionspheric/magnetospheric phenomena. The focus of current operations for U.S. forces is primarily in mid-latitudes, with existing systems and technologies optimized for use in these latitudes. The high latitudes of the Arctic comprise an emerging operational domain for which new technologies are needed.<br><br>(U) Mapping the extent and thickness of the sea ice in the Arctic is fundamental to operations in this region. Current technologies exist for the wide area mapping of the extent of the Arctic sea ice, e.g., satellite-based synthetic aperture radar, but the mapping of the thickness of the ice relies primarily on electro-magnetic induction point measurements above the ice followed by interpolations between these points, which is a very slow process. The program will develop technology for rapid, wide area mapping of ice thickness to determine where to surface through the ice, as well as chart courses through the ice. This technology will build upon space- and/or aircraft-based millimeter-wave radar (based on technologies developed under the MEO-SAR program budgeted under PE 0603287E, Project SPC-01), | 0.000 | 0.000 | 5.000 | 0.000 | 5.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| shore- and/or ship-based HF surface radar, upward-looking sonar on fixed or mobile nodes, and new modeling methods. Enhancing situational awareness for U.S. forces in the Arctic is an additional benefit of the mapping technology to be developed by the program.<br><br>(U) The program will also develop technologies that will enable a navigation and communication infrastructure for future platforms and sensors operating under the Arctic ice. This infrastructure includes leave-behind, through-ice nodes that act as beacons and communication ports, low-power trans-Arctic acoustic transmitters for GPS-like navigation, and navigation via scene mapping relying on detailed bottom bathymetry. The through-ice nodes will need to generate sufficient thermal power to melt through the ice, and advances in miniature combustion engines provide one path to achieve this goal that is superior to past failed efforts using chemical reactions and batteries. Long-baseline acoustics for GPS-like navigation has never been done, but recent scientific work on low-power, flow-frequency sound propagation to measure ocean temperatures suggests feasibility. This program plans to transition to Navy, Air Force, Marines, and Army in FY 2015.<br><br>*FY 2011 Base Plans:*<br>- Develop conceptual designs for revolutionary technologies to enhance rapid mapping of ice thickness and/or navigation and communication beneath the ice for high latitude operations.<br>- Establish proof-of-concept for technologies to rapidly map ice thickness and/or navigate and communicate beneath the ice for high latitude operations. | | | | | |
| Speckle Exploitation for Enhanced Reconnaissance (SEER)<br><br>(U) The Speckle Exploitation for Enhanced Reconnaissance (SEER) program provided long-range, non-cooperative identification of moving/stationary targets using incoherent scattered laser speckle reflected off a target surface. Laser speckle has reduced sensitivity to adverse turbulence-induced distortion and so provides a viable signal at ranges exceeding those projected for other active laser systems. Technical achievements under other programs in this PE/Project provided the basis | 6.000 | 0.000 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| for radically new approaches to measuring target characteristics under conditions that limit the performance of conventional sensors. Target characteristics potentially obtainable may include target image, shape, size, structural features, and other advanced threat properties. By extending the operating range of current active electro optic sensors, SEER enabled the friendly platform to stand off from the maximum operating range of hostile sensors/weapons, while executing the targeting task and directing weapons against targets.<br><br>*FY 2009 Accomplishments:*<br>- Developed algorithms that reliably and uniquely associate target signatures with speckle patterns.<br>- Implemented algorithms using optical Micro Electro-Mechanical systems (MEMs) or other related technologies to achieve reduced size, weight and power. | | | | | |
| Cross-Border Tunnel (CBT)<br><br>(U) The Cross-Border Tunnel (CBT) program investigated technologies and systems to detect small tunnels used to breach security perimeters and national borders. The program goal was to develop innovative technologies inspired by geophysical exploration techniques that detect and characterize these threat tunnels while simultaneously satisfying operational considerations such as search rate, site access, monitoring persistence, and exposure of friendly forces. The initial CBT program thrust performed collections of seismic and electromagnetic (EM) data at a test bed using current state of the art sensors from the geophysical industry.<br><br>(U) The program's recent focus was on a Fast-Scan CBT detection technique. This technique investigated developing a tunnel detection system focused on providing a fast linear scan rate, for operationally tractable protection of large controlled areas or national borders. Current subterranean interrogation techniques based on geophysical exploration methods have the combined impediments of slow interrogation rate, need for complete site access, or exposure of forces. Contrary to invasive imaging methods, the Fast-Scan concept would provide rapid detection of anomalous subsurface | 3.750 | 0.000 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| structures consistent with voids. Technical challenges included: 1) identification of optimal detection strategies, source characteristics, and sensor geometries, 2) rejection of clutter with length scales similar to tunnels or response from non-threat structures (utilities), and 3) technology migration to a moving platform. This study completed and data transitioned to the Services in FY 2009.<br><br>*FY 2009 Accomplishments:*<br>- Completed study to determine the design requirements for the source characteristics and sensor/ source geometry that optimizes the detection performance. | | | | | |
| Accomplishments/Planned Programs Subtotals | 63.703 | 50.619 | 42.286 | 0.000 | 42.286 |

**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 2009 Actual | FY 2010 Estimate | FY 2011 Base Estimate | FY 2011 OCO Estimate | FY 2011 Total Estimate | FY 2012 Estimate | FY 2013 Estimate | FY 2014 Estimate | FY 2015 Estimate | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEN-02: *SENSORS AND PROCESSING SYSTEMS* | 118.880 | 99.486 | 82.541 | 0.000 | 82.541 | 87.179 | 87.211 | 90.095 | 92.986 | Continuing | Continuing |

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

(U) The Sensors and Processing Systems project develops and demonstrates the advanced sensor and processing technologies and systems necessary for military's intelligence, surveillance, and reconnaissance (ISR) missions. Future battlefields will continue to be populated with targets that use mobility and concealment as key survival tactics, and high-value targets will range from specific individual insurgents and vehicles to groups of individuals and large platforms such as mobile missile launchers and artillery. The Sensors and Processing Systems project is primarily driven by four needs: (a) providing day-night ISR capabilities against the entire range of potential targets; (b) countering camouflage, concealment and deception of mobile ground targets; (c) detecting and identifying objects of interest/targets across wide geographic areas in near-real-time; and (d) enabling reliable identification, precision fire control tracking, timely engagement and accurate battle damage assessment of ground targets. The Sensors and Processing Systems project develops and demonstrates technologies and system concepts that combine novel approaches to sensing with emerging sensor technologies and advanced sensor and image processing algorithms, software, and hardware to enable comprehensive knowledge of the battlespace and detection, identification, tracking, engagement and battle damage assessment for high-value targets in all weather conditions and combat environments.

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Network Centric Sensing and Engagement | 5.015 | 3.426 | 0.000 | 0.000 | 0.000 |
| (U) The Network Centric Sensing and Engagement program develops technology and tools to support precise small unit situational awareness, rapid targeting, and precision engagement in highly-networked environments. Network-centric sensing acknowledges a group of sensors as a system and leverages networked intercommunication to enable system performance superior to that of uncoordinated individual sensors. The program uses organic reconnaissance, surveillance and target acquisition data to update tactical users and planners over multiple echelons with critical environmental and operational information. Required technology advances include: sensor-to-sensor communications, multi-sensor management, sensor system georegistration, real-time data fusion, advanced tracking, and network- | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| centric sensor operational modes. Technologies are planned to transition to small tactical units in irregular operations.<br><br>*FY 2009 Accomplishments:*<br>- Evaluated the effect of combining multiple organic sensor updates on situation assessment for rapid military riverine operations.<br><br>*FY 2010 Plans:*<br>- Evaluate the effect of combining multiple semi-autonomous organic sensor updates and novel display technologies on situation assessment for rapid military riverine operations. | | | | | |
| Advanced Radar Sensor Technology<br><br>(U) The Advanced Radar Sensor Technology thrust develops radar systems to provide significant improvements in our ability to detect, identify, and track surface targets and threats over very wide areas in all climatic conditions. Program efforts focus on exploiting emergent and novel RF sensing technology and phenomenology. Key elements are advancements in ultra-wide band, bistatics, UHF/VHF, emitter location and direction-finding, polarimetric change detection, tomographic imaging, space-time adaptive processing and other advanced signal processing, advanced Ground Moving Target Indicator (GMTI) techniques, and foliage, building, and ground-penetrating radar phenomenology. Program developments are integrated with current and emerging military platforms, including small and micro UAVs, with emphasis on the most stressing military radar sensor challenges. Examples are operations featuring complex cluttered ground environments; those against small and slow moving surface targets; urban operations, and situations where camouflage, decoys and countermeasures must be overcome. Programs in this thrust include:<br><br>• The Next Generation RF Antenna System program will develop and demonstrate a light-weight wide-band RF antenna that enables high gain over a broad frequency range and signal detection at extended ranges. This program is planned for transition to the U.S. Air Force. | 6.124 | 6.396 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| • The Airborne Passive Direction Finding with a Tactical Vector Sensor (ATVS) program will develop and demonstrate a compact, lightweight, airborne, real-time, tactical emitter detection and location system suitable for tactical UAVs. This program is planned for transition to the U.S. Army.<br><br>• The Efficient Digitization of Element Signals program will exploit new and emerging techniques in signal coding and compressive sensing to allow large, element-count, radio frequency (RF) arrays to be digitally sampled using small numbers of receivers. Technologies are planned for transition to the Navy, Army and Air Force.<br><br>*FY 2009 Accomplishments:*<br>Next Generation RF Antenna System<br>- Refined electromagnetic models.<br>- Fabricated and measured RF properties.<br>- Demonstrated non-reciprocity with real meta-materials and showed agreement with models.<br><br>*FY 2010 Plans:*<br>Next Generation RF Antenna System<br>- Design a novel antenna with superior gain and bandwidth.<br>- Validate design using electromagnetic modeling.<br>- Commence fabrication of first prototype antenna.<br><br>Airborne Passive Direction Finding with a Tactical Vector Sensor (ATVS)<br>- Develop prototype ATVS antenna and measure RF performance characteristics in an outdoor range.<br>- Design complete ATVS system.<br><br>Efficient Digitization of Element Signals | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Develop general compressive sampling techniques which exploit sparsity in RF signal space and/or time.<br>- Use a combination of signal coding and sample selection to allow the element signals to be received and sampled by a small number of digital receivers and to recover the original element signals digitally through a combination of decoding and interpolation. | | | | | |
| NetTrack* | 9.970 | 7.890 | 2.000 | 0.000 | 2.000 |
| *Previously part of Advanced Radar Sensor Technology.<br><br>(U) DARPA's NetTrack Program is developing feature aided tracking technologies to enable airborne surveillance radars to maintain track on moving High Valued Targets (HVTs) in traffic and cluttered environments. Ground Moving Target Indicator (GMTI) radars provide excellent potential for tracking high value targets because they operate in all weather and at long ranges. However, maintaining target tracks is very challenging because obscuration and close target spacing make it difficult to associate radar kinematic measurements over time. To address this challenge, NetTrack is developing feature aided tracking technology that automatically collects and exploits target high range resolution (HRR) radar measurements. Specific NetTrack technologies include signal processing to generate HRR measurements from raw radar returns, feature extraction and matching to exploit HRR measurements, multiple hypothesis tracking to associate measurements to tracks and estimate target location and velocity, and sensor resource management to automatically select optimum radar mode parameters and timing sequences. Technologies are planned for transition to the Navy, Army and Air Force.<br><br>*FY 2009 Accomplishments:*<br>- Demonstrated radar signature-aided vehicle tracking.<br>- Tested initial NetTrack capabilities in an operational airborne radar system.<br><br>*FY 2010 Plans:*<br>- Demonstrate NetTrack capabilities in real-time on operational radar platform. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2011 Base Plans:*<br>- Complete demonstration of NetTrack capabilities.<br>- Transition to the U.S. Services. | | | | | |
| Advanced Airborne Optical Sensing | 5.933 | 13.576 | 16.379 | 0.000 | 16.379 |
| (U) The Advanced Airborne Optical Sensing program develops electro-optical and infrared sensors and surveillance for aerial platforms. Significant challenges arise as the result of two warfighting trends. First, the ever-changing mix of airborne platforms now includes a greater number of smaller UAVs. Second, the target set is increasingly challenging and now includes vehicles and individual dismounts that operate under foliage and in urban canyons, using camouflage, obscurants, and other means of concealment. In response to these challenges, the Advanced Airborne Optical Sensing program brings recent advances in optical, electro-optical, photonic and other technologies to airborne optical sensing systems. Specific examples of these technologies include: embedded image processors tailored to real-time detection, identification, and tracking of military targets; hyper-spectral sensing technologies; flash detection, and underwater object detection; advanced laser radar technologies; advanced digital signal processing to support onboard image reconstruction, atmospheric correction, and system calibration; video exploitation techniques, including new approaches to scene understanding and activity detection; and adaptive optics techniques, such as deformable mirrors and liquid crystal spatial light modulators. The program extends these technologies and makes them practical for airborne surveillance systems. Efforts in this program include:<br><br>• The Standoff Precision ID in 3-D (SPI 3-D) program is developing an affordable sensor package capable of high-resolution 3-D images for confirmatory target ID at long ranges as well as full field of view (FOV) ranging to support precise geolocation of targets. The system provides intensity, range and polarization information for each pixel in the field of view with each laser pulse. The program includes a series of ground-based and airborne demonstrations of SPI 3-D precision ID capabilities and track fusion techniques. The objectives are to provide: (1) high range resolution 3-D imaging; | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| (2) full FOV range to pixel determination; (3) multiple frame-to-frame registration of imagery, and (4) GPS-based cueing from search systems. Results will provide commanders with significantly improved long-range identification of enemy ground targets, as well as targeting information to support guided weaponry. The SPI 3-D system employs optics, focal plane arrays, and gimbals combined with a range measurement technique. SPI 3-D technologies are being designed to be compatible with operational ISR systems and may be installed in a joint-service ISR pod (such as LITENING) or a Class IV UAV (Predator, Firescout & Warrior) Multi-spectral Targeting System (MTS) turret. A manned airborne demonstration of SPI-3D components in an ISR pod will be performed to illustrate SPI-3D capabilities. Subsequent to the manned airborne demonstration, transition will be to the U.S. Air Force at the conclusion of Phase III. The program will produce high speed, ultra sensitive photodetectors for systems requiring operation at very low photon counts. This will support long range sensors that can detect highly obscured targets under canopy/camouflage as well as very wide-area search for submerged targets including sea mines and semi-submerged mobile vessels. Video and 3-D imaging through obscurants (VITO) will enable robust under-canopy, high-resolution real-time 3-D video and imagery and for target detection, identification, and tracking based on real-time Volumetric Change Detection (VCD) or Volumetric Moving Target Indication (VMTI). VITO will employ high speed, ultra sensitive photo-detectors and selective range gate processing to permit improved viewing under obscurations. The system will operate at altitudes and standoff ranges compatible with manned and unmanned aircraft.<br><br>• Spatially Processed Image Detection and Ranging (SPIDAR) is a coherent imaging method that allows one to form a large, effective optical aperture from a set of smaller, lighter telescopes providing for very high-resolution 3-D and 2-D ladar imagery of distant targets with a compact system configuration. This capability is very well suited for long-range engagements from airborne or space-based platforms and could significantly enhance the current synthetic aperture imaging approaches by providing the desired cross-range resolution along the axis perpendicular to the direction of travel. This capability is also applicable on a small scale to provide very-high resolution imagery in a compact and | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| potentially man-portable configuration for long-range ID. The gain in size, weight and power over more conventional lidar implementations will be assessed and demonstrated. Additionally, suitable missions and platforms for the technology will be identified. SPIDAR technologies will be transitioned to the U.S. Air Force in FY 2013.<br><br>• The Tactical Aircraft to Increase Long Wave Infrared Nighttime Detection (TAILWIND) program will develop and demonstrate a system for collecting and processing IR data operating as a framing sensor. The system will accept long wave infrared and color camera images permitting day/night reconnaissance for real-time target detection and tracking. The resulting sensor and processing system will provide an order of magnitude increase in the combination of area coverage over current systems, and a decrease in time to focus the sensor operator's attention on relevant targets. The TAILWIND system is planned for transition to the U.S. Army by FY 2012.<br><br>*FY 2009 Accomplishments:*<br>Standoff Precision ID in 3-D (SPI 3-D)<br>- Successfully completed Phase 2 flight demonstrations supporting analysis of performance for next phase of the program.<br>- Initiated SPI 3-D Phase 3 development effort in concert with the Air Force Predator System program office development of the MTS turret to ensure SPI-3D compatibility with the MTS.<br><br>Spatially Processed Image Detection and Ranging (SPIDAR)<br>- Conducted initial assessment of the performance of the current system configurations and systems analysis of long-range, high-resolution imaging applications.<br>- Identified the trade space for considering multi-aperture receivers and illuminators in the system designs.<br>- Developed conceptual system designs to achieve desired system performance.<br><br>Tactical Aircraft to Increase Long Wave Infrared Nighttime Detection (TAILWIND) | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Completed preliminary design of infrared and color sensor package.<br>- Developed system design and data flow through to the user.<br><br>*FY 2010 Plans:*<br>Standoff Precision ID in 3-D (SPI 3-D)<br>- Complete fabrication of miniaturized components and initiate integration into the demonstration system.<br>- Develop techniques for target detection, identification, and tracking based on real-time Volumetric Change Detection (VCD) or Volumetric Moving Target Indication (VMTI).<br>- Perform initial design studies for a Geiger-mode Avalanche Photodiode (GmADP) array-based sensor that provides robust under-canopy, high-resolution real-time 3-D video and imagery using selective range gate processing.<br><br>Spatially Processed Image Detection and Ranging (SPIDAR)<br>- Initiate development of mountain-to-ground multi-aperture system outdoor demonstration to validate system modeling.<br>- Initiate airborne demonstration system design and key component technology demonstrations.<br>- Initiate conformal aperture sub-system demonstration development.<br><br>Tactical Aircraft to Increase Long Wave Infrared Nighttime Detection (TAILWIND)<br>- Complete detailed design of infrared and color sensor package.<br>- Develop parallel processing, compression, and image exploitation algorithms.<br>- Develop passive infrared exploitation technologies.<br><br>*FY 2011 Base Plans:*<br>Standoff Precision ID in 3-D (SPI 3-D)<br>- Complete integration of miniaturized components into the demonstration system. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Conduct airborne demonstration of the Metric Sensing and 3-D imaging on a manned aircraft supporting transition to U.S. Air Force.<br>- Design and implement VCD/VMTI-based target detection, identification, and tracking algorithms in high-performance signal processing hardware architectures.<br>- Hold preliminary design review and initiate fabrication of a prototype sensor for under-canopy 3-D video and imaging.<br>- Develop promising technologies identified for use for air platform to air target identification and location.<br><br>Spatially Processed Image Detection and Ranging (SPIDAR)<br>- Complete multi-aperture mountain-to-ground demonstration and validate system performance modeling.<br>- Complete airborne system design with validated performance models meeting objective increase in spatial resolution.<br>- Complete supporting critical technology demonstrations.<br><br>Tactical Aircraft to Increase Long Wave Infrared Nighttime Detection (TAILWIND)<br>- Integrate sensor package into target aircraft.<br>- Perform field test of sensor system. | | | | | |
| Wide Area Video Surveillance<br><br>(U) The Wide Area Video Surveillance program is developing advanced electro-optical and infrared sensor technologies to enable persistent, wide-area, day-night video surveillance. Specific examples of these technologies includes: gigapixel focal plane arrays; advanced digital signal processors for giga-pixel image formation; advanced image processing algorithms for real-time detection, identification, and tracking of elusive and deceptive military targets; and advanced optics, telescopes and gimbals for high-resolution image capture. The Wide Area Video Surveillance program integrates these technologies in proof-of-concept prototypes for demonstration on military platforms including large and | 14.750 | 20.000 | 16.000 | 0.000 | 16.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| small, manned and unmanned aerial vehicles. Wide Area Video Surveillance technologies are planned for transition to the U.S. Air Force. Efforts in this program include:<br><br>• The Autonomous Real-time Ground Ubiquitous Surveillance – Imaging System (ARGUS-IS) program is developing an airborne sensor system that provides persistent, real-time, high-resolution, wide-area video surveillance. ARGUS-IS will provide the warfighter with a minimum of sixty-five "Predator like" video windows across the field of view. Each video window is electronically steerable and independent of the others. ARGUS-IS can also provide a global moving target indicator for vehicle size objects across the entire field of view. ARGUS-IS is comprised of three major subsystems: (1) a Gigapixel Sensor Subsystem (GSS) which consists of a set of four telescopes and is mounted in a 3-axis stabilized gimbal; (2) an Airborne Processing Subsystem (APS) which takes raw pixels from the GSS and performs all required processing; and (3) a ground processing subsystem which provides the interface to the user and records down-linked imagery. A Memorandum of Agreement (MOA) for the transition of ARGUS-IS from DARPA to the U.S. Air Force has been executed. The transition period is FY 2009 - FY 2010.<br><br>• The Autonomous Real-time Ground Ubiquitous Surveillance – Infrared (ARGUS-IR) program is developing an airborne sensor system that provides a persistent, real-time, high-resolution, wide-area night video surveillance capability. ARGUS-IR uses an advanced infrared (IR) focal plane array (FPA) sensor. The nighttime persistent capability provided by ARGUS-IR combined with the daytime capability provided by ARGUS-IS enables 24-hour day/night surveillance. ARGUS-IR's wide-area, high-update-rate, high-resolution imaging capability will enable detection and tracking of dismounts as well as vehicles. ARGUS-IR will utilize the signal/image processor developed as part of ARGUS-IS, enabling ARGUS-IS and ARGUS-IR to be combined into a common pod. ARGUS-IR must overcome a number of demanding technical challenges beyond those faced by ARGUS-IS. The most significant challenges relate to the IR FPA and size, weight, and power constraints for the IR sensor. Technologies are planned for transition to the U.S. Air Force. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2009 Accomplishments:*<br>Autonomous Real-time Ground Ubiquitous Surveillance – Imaging System (ARGUS-IS)<br>- Completed the build of the 1.8 gigapixel sensor, airborne processing system, pod, and ground processing.<br>- Integrated sensor, airborne processor, and data link into ARGUS-IS pod.<br>- Completed Phase 2 software development for ground processing and airborne processing systems.<br>- Conducted flight experiments for video windows and video tracking.<br>- Began building a copy of the sensor and airborne processor for U.S. Air Force.<br>- Executed MOA with the U.S. Air Force for flight testing of ARGUS-IS on an MQ-9 Reaper unmanned air vehicle.<br><br>*FY 2010 Plans:*<br>Autonomous Real-time Ground Ubiquitous Surveillance – Imaging System (ARGUS-IS)<br>- Complete build and delivery of sensor and airborne processing systems for U.S. Air Force.<br>- Integrate sensor and airborne processing systems into a compatible pod.<br>- Integrate ARGUS-IS pod with target platform.<br>- Conduct flight tests that will validate the video windows and video tracking functionality.<br><br>Autonomous Real-time Ground Ubiquitous Surveillance – Infrared (ARGUS-IR)<br>- Develop prototype IR FPA.<br>- Develop packaging approach appropriate for the target gimbal.<br>- Begin development of optics for IR sensor.<br><br>*FY 2011 Base Plans:*<br>Autonomous Real-time Ground Ubiquitous Surveillance – Infrared (ARGUS-IR)<br>- Build the IR FPAs.<br>- Complete development and build of optics for IR Sensor.<br>- Integrate IR sensor into gimbal. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Large Area Coverage Search-while-Track and Engage (LACOSTE) | 12.150 | 12.460 | 4.110 | 0.000 | 4.110 |

(U) The Large Area Coverage Search-while-Track and Engage (LACOSTE) program enables a persistent, tactical-grade ground moving target indicator (GMTI) capability in dense urban areas. Wide-area continuous tracking of moving vehicles requires very small coverage gaps, small resolution cells, and target separation and identification features. The ideal sensor has the area coverage rates of GMTI radar and the resolution/identification capabilities of an electro-optical infrared system. The LACOSTE program will provide wide area surveillance, simultaneous tracking, and target engagement with electro-optical and infrared sensors for tactical GMTI operations. The program is developing a sensor with a very wide field of regard (90 degree cone angle), and a wide instantaneous field of view (FOV) that is rapidly scanned in a search-while-track mode, tracking up to 10,000 targets in an urban area. Additionally, the LACOSTE sensor will provide next-generation precision tracking to enable engagement on a large number of (approximately 100) targets in dense urban areas within that same field of regard with minimal penalty on the search-mode area coverage rate. The program is also developing a rapid “zoom” capability for target identification that enables feature-aided tracking through dense target environments, plus sufficient target identification for separating like-targets when back-tracking a particular target via the historical track data. The LACOSTE technology is planned for transition to the U.S. Air Force and the U.S. Army at the conclusion of the program.

*FY 2009 Accomplishments:*
- Completed scaled integration of core system technologies.
- Developed and tested computational imaging and tracking algorithms.

*FY 2010 Plans:*
- Manufacture and test full-scale components.
- Perform system integration and laboratory testing.
- Demonstrate performance (sensitivity, resolution, and tracking) via tower testing.

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2011 Base Plans:*<br>- Conduct helicopter demonstration of sensitivity, resolution, and tracking. | | | | | |
| Sensor Tape*<br>*Previously part of Soldier-borne Sensor Technology.<br><br>(U) The Sensor Tape program will develop and demonstrate a low-cost, one-time-use, low-power, band-aid size, adhesive-applied blast dosimeter that records accumulative blast effects for integration into combat medical care. Significant technical obstacles that must be overcome include achieving adequate switching frequencies, packaging, print-on ink technologies and production costs. Sensor Tape is planned for transition to the Air Force and Army.<br><br>*FY 2009 Accomplishments:*<br>- Demonstrated proposed sensors and communications capability in controlled laboratory experiments.<br>- Integrated modules into a complete first generation prototype blast dosimeter.<br>- Developed jet-printing processes required for printed sensors, printed electronics and printed memory components.<br>- Developed printed pressure, acceleration, light and acoustic sensors.<br>- Developed proposed sensors and communications capability in controlled laboratory experiments.<br><br>*FY 2010 Plans:*<br>- Demonstrate web-printing process for sensors, printed electronics and memory components.<br>- Fabricate prototype sensor tapes.<br>- Demonstrate sensor tape performance in field test. | 2.046 | 2.282 | 0.000 | 0.000 | 0.000 |
| Super-Resolution Vision System (SRVS)* | 9.482 | 8.894 | 11.917 | 0.000 | 11.917 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *Previously part of Ground Targeting Sensors.<br><br>(U) The Super-Resolution Vision System (SRVS) program will develop and build a field prototype soldier-portable optical system that will demonstrate improved recognition and identification range over existing systems. The key technical innovation is exploitation of atmospheric turbulence-generated micro-lensing phenomena to generate images that are superior to diffraction-limited images. A variation of lenses approach, to include adaptive polymer lenses, will also be investigated. SRVS will facilitate new operational and tactical opportunities for land forces. Through enhanced resolution imaging, SRVS will (1) extend target recognition and identification to decisively longer distances; (2) overcome atmospheric turbulence, which now limits the ability of high-resolution optics; and (3) increase target identification confidence to reduce fratricide and/or collateral damage. It will culminate in a field demonstration of a prototype.<br><br>(U) Additionally, the program will investigate the ability to overcome field of view (FOV) and depth of field (DOF) limitations of conventional optical systems such as those encountered in macro photography by obviating the need for steering or focusing of the optical system through the use of conventional lenses. Recent advances in laser systems, digital imagers, and novel image processing algorithms will be leveraged. It is expected that combining this approach with active 3D laser radar systems will result in the reduction of the overall size, weight and power of imaging systems while providing high-resolution detail at several ranges for target identification purposes. Technology developed under this program will transition to Special Operations Forces.<br><br>*FY 2009 Accomplishments:*<br>- Conducted demonstration and testing of prototype systems.<br>- Modified design based on experiments and testing to support transition.<br><br>*FY 2010 Plans:*<br>- Conduct conceptual studies to identify possible lens variations, including adaptive polymer lenses. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Commence fabrication and testing of soldier portable prototype.<br>- Conduct field testing of system performance.<br>- Identify system designs for several compact, high-resolution 3D imaging systems.<br>- Initiate development of critical hardware subsystems for high-resolution 3D imaging systems.<br><br>*FY 2011 Base Plans:*<br>- Complete development of critical hardware subsystems for high-resolution 3D imaging systems.<br>- Develop advanced image processing algorithms for high-resolution 3D imaging systems.<br>- Commence integration of subsystems for laboratory demonstration of high-resolution 3D imaging capability. | | | | | |
| Short Wave Infrared through Fog and Clouds (SWIF)*<br>*Previously part of Ground Targeting Sensors.<br><br>(U) The Short Wave Infrared through Fog and Clouds (SWIF) program will develop and demonstrate advanced signal processing and optical imaging technology to allow detection of collision and grounding threats in fog and clouds at useful ranges (day or night), which substantially degrade performance in precision handling operations. Humans are able to operate successfully with sensor assistance, but situational awareness significantly degrades. Successful development of this technology will restore this situational awareness to tactically relevant distance and time scales. Significant technical obstacles that must be overcome include development of an ultra-short pulse laser with sufficient bandwidth and fast enough pulse rise time to create transient-like propagation characteristics in an aerosol cloud, distributed active sources, and advanced filtering techniques. Technologies are planned for transition to the U.S. military.<br><br>*FY 2009 Accomplishments:*<br>- Conducted modeling and simulation to optimize system range and resolution. | 8.781 | 7.562 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Conducted experiments under various scattering and absorption conditions to characterize optical link budget.<br>- Developed distributed active obscurant technologies.<br>- Packaged and tested distributed obscurant.<br><br>*FY 2010 Plans:*<br>- Manufacture test articles.<br>- Distribute obscurant chamber testing and system validation. | | | | | |
| Precision Electronic Warfare (PreEW)<br><br>(U) The Precision Electronic Warfare (PreEW) program will develop a system to enable highly precise communications jamming. This program will develop and demonstrate robust, low cost, small size, weight and power (SWAP) distributed electronic warfare (EW) platforms to allow the warfighter to disrupt and impede an adversary's communication network. The PreEW program uses an array of nodes that have synchronized clocks to enable the signal from each node to be aligned so that the carrier and phase are focused on the desired location. The effect will be to place the desired energy on the specific target area while not affecting the non-target area. The node is planned to contain localization, network, synchronization and jamming processing and communication in a low-cost, easily deployable package. Key technology challenges include oscillator synchronization, accurate pointing, and energy focusing to impact quality of service of intended target. The PreEW program is planned for transition to the Services in FY 2013.<br><br>*FY 2010 Plans:*<br>- Design and develop precision clock synchronization techniques for evaluation and selection for static scenarios.<br>- Design beamforming and inter-mode communication architecture.<br>- Experiment with brassboard design to validate ability for small SWAP. | 0.000 | 10.000 | 14.000 | 0.000 | 14.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Perform experiments to validate clock synchronization, precision pointing, and precision jamming capabilities.<br><br>*FY 2011 Base Plans:*<br>- Design prototype nodes for demonstration purposes.<br>- Conduct initial test using pole mounted payloads. | | | | | |
| Transparent Earth<br><br>(U) The goal of the Transparent Earth program is to determine the physical, chemical, and dynamic properties of the earth down to 5 km depth, including natural or man-made structures at militarily-relevant spatial scales. The program will focus on two key challenges: the first is to develop a common data model for, or mathematical description of, a three-dimensional section of the earth, to enable aggregation of disparate measurements. The second challenge is to take advantage of emerging sensors and natural indicators of subsurface activity and combine these (along with existing sources) with new algorithms/mathematics (based on algorithm developments under the Airborne Tomography using Active Electromagnetics (ATAEM) program in Project SEN-01) to estimate physical/chemical properties for volumetric elements throughout the earth. Success in these two challenges will lead to the integration of the volumetric elements into a global three-dimensional picture of the earth's subsurface with variable spatial, temporal, and information resolution, allowing changes at local scales to propagate through both physical models and proximity rules to update the global picture. Transparent Earth technology is anticipated to transition to the Army, Air Force, and SOCOM, as well as mapping/intelligence organizations such as NGA and DIA in 2015.<br><br>*FY 2011 Base Plans:*<br>- Identify and develop promising approaches for the development of new mathematical descriptions of local sections of the underground for common earth-sensing measurements.<br>- Identify and demonstrate feasibility of novel sensors and new mathematics to allow integration of disparate measurement scales. | 0.000 | 0.000 | 4.000 | 0.000 | 4.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Precision Inertial Navigation Systems High Dynamic Range Atom System (PINS HiDRA)<br><br>(U) Precision Inertial Navigation Systems High Dynamic Range Atom System (PINS HiDRA) will develop an integrated atom-based navigation system suitable for use on a wide range of military platforms. The program will build on the work of the Precision Inertial Navigation Systems (PINS) program (funded in PE 0603768E, Project GT-01) to dramatically increase the dynamic range of the sensors, thereby enabling operation on aircraft and missiles. Extensive system integration and miniaturization will reduce system size, weight, and power, while increasing navigation performance as measured against currently fielded aircraft inertial navigation systems. Key technology challenges include high brightness atom sources, innovative atom interferometer measurement schemes that function in high dynamic environments, and high g-tolerant laser stabilization schemes. The PINS HiDRA program will focus on transition to the Services in FY 2014.<br><br>*FY 2011 Base Plans:*<br>- Design system microcontroller and compact laser and optomechanics frame.<br>- Develop computer models for atom sensor operation under high dynamic input and predict navigation performance under relevant sensor configuration.<br>- Validate sub-system technology selections and incorporate into full six degree-of-freedom inertial sensor design. | 0.000 | 0.000 | 6.135 | 0.000 | 6.135 |
| Persistent Operations Surface Surveillance and Engagement (POSSE)*<br><br>*Previously part of Persistent Exploitation.<br><br>(U) The Persistent Operations Surface Surveillance and Engagement (POSSE) program is developing the capability to integrate sensor input from multiple modalities to find indications of insurgent activities. Combined with dynamically updated information from soldiers on the ground, POSSE will enable near-real-time generation of the evidence necessary for further investigation or interdiction. POSSE experiments are conducted at the National Training Center (NTC) with realistic role players emulating | 19.178 | 0.000 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| typical residential, commercial and light industrial activity. Within this environment, insurgent activity is simulated by qualified experts using the latest and most complete intelligence available. Measurements include precision collections of insurgent activities, as well as the realistic surrounding background clutter of typical civilian activity. Results will inform future experiments, lead to specifications for future sensor design, and provide insights into how to integrate other narrow and wide area sensors into an integrated approach to countering insurgencies. Transition is planned for U.S. Army Intelligence and Security Command. The concepts and technology developed in this program will continue in PE 0603767E, Project SEN-03.<br><br>*FY 2009 Accomplishments:*<br>- Conducted two chemical detection experiments to characterize the chemical environment and quantify signatures associated with the bomb making enterprise within this environment.<br>- Continued data analysis and algorithm development to correlate chemical signatures over time and space to help reveal the bomb maker network. | | | | | |
| Target Identification Technology<br><br>(U) The Target Identification Technology thrust develops semiautomatic methods to identify targets from sensors operating in all spectral bands. Its objective is to detect, characterize, and identify military threats, and to assess the environment around them. Data sources include national, theater, and organic sensors. Exploiting the acoustic emissions of potential targets is of interest because acoustics has the advantage of not requiring an unobstructed line of sight between the emitter and sensor, and under certain circumstances sound may propagate great distances. Critical performance metrics are timeliness, accuracy, error rates, and interpretation workload. The thrust addresses the challenges of target identification, acquisition and tracking under restrictive rules of engagement. The technologies will apply advanced signal processing and machine vision to leverage advances in sensor capabilities. The concepts and technology developed in this program will continue in PE 0603767E, Project SEN-03. | 9.000 | 0.000 | 0.000 | 0.000 | 0.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| • The All-Source Target Characterization program developed a collection and measurement capability to characterize new targets as they emerge on the battlefield. This effort developed tools to permit rapid user interaction with imagery, sensor data, and processing results and provided real-time feedback to operators indicating key target features and other discriminates. This initiative also evaluated robust target cueing and identification over large classes of targets within a computational form factor appropriate for insertion into strike aircraft and unmanned aerial vehicles. The technology provides tools to process and disseminate target signatures to the field in usable formats for direct insertion into operational systems.<br><br>• The Small Unmanned Aerial Vehicle Detection System (SUDS) program develops techniques to detect, track, and provide discrimination between friend and foe against small UAVs that are easily built, inexpensive, easy to operate, and offer the asymmetric adversary an ability to reach into U.S. defended locations causing potentially large amounts of damage. It includes antenna and signal processing techniques to passively detect small air targets using radar, video, acoustic, and radio-frequency sensors; to correlate those data with known objects (e.g., civilian aircraft); to analyze the motion of any uncorrelated data; and to rapidly task narrow-field-of-view sensors to collect more-detailed data. It will transition to the Services to meet both static force protection needs and tactical air defense operations.<br><br>*FY 2009 Accomplishments:*<br>All-Source Target Characterization<br>- Evaluated performance in field exercises and demonstrations.<br><br>Small Unmanned Aerial Vehicle Detection System (SUDS)<br>- Developed algorithms to identify and classify targets and objects of interest.<br>- Performed tests against UAV and radio controlled (RC) aircraft of known and unknown characteristics to demonstrate the system's ability to improve target detection and classification.<br>- Performed data collection to determine acoustic features/signatures/characteristics.<br>- Applied results to physics models of aircraft and propulsion systems. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| SandBlaster* | 2.000 | 1.000 | 1.000 | 0.000 | 1.000 |
| *Previously part of Ground Targeting Sensors.<br><br>(U) The SandBlaster program developed a helicopter pilot performance enhancement system for landing in degraded visual environments such as Iraq and Afghanistan dust clouds. Sandblaster addressed this important operational challenge in a Blackhawk platform environment, in four distinct areas: (1) Advanced flight controls which enable the helicopter to auto-land at a pilot-selected landing point; (2) See-through sensing based on a forward-looking three dimensional W-band radar, which enables the pilot to see through the dust and select a safe landing point; (3) A powerful fusion engine which combines map and obstacle database knowledge with real-time radar data to construct a full current assessment of landing zone hazards; and (4) An enhanced synthetic vision display to present this evolving real-time landing zone information to the pilot in the most useful manner, combined with all necessary aircraft-state symbology needed to complete a safe landing. The technology developed under this program transitioned to U.S. Special Operations Command (USSOCOM), the U.S. Air Force and the U.S. Army.<br><br>*FY 2009 Accomplishments:*<br>- Completed Sandblaster system performance testing and demonstrated capabilities in the JUH-60A Blackhawk helicopter.<br>- Transitioned Sandblaster technology to the services.<br><br>*FY 2010 Plans:*<br>- Commence design of a lighter weight system for use on DoD operational helicopters.<br><br>*FY 2011 Base Plans:*<br>- Complete design of a lighter weight system for use on DoD operational helicopters. | | | | | |
| Crosswind Sensor System for Snipers (C-WINS)* and Dynamic Image Gunsight Optics (DInGO) | 6.951 | 6.000 | 7.000 | 0.000 | 7.000 |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *Previously part of Soldier-borne Sensor Technology.<br><br>(U) The Crosswind Sensor System for Snipers (C-WINS) program provided optical techniques to correct for crosswinds on ballistic objects. The C-WINS program developed a novel weapon mounted optical correction sighting system for various rifles and machine guns. An eye safe laser and a high speed camera record motion of eddies in the atmosphere to measure the wind profile that will be used to provide ballistic correction. The system provides offset corrections to the shooter for compensating the aim point affected by the crosswind. Key parameters of interest are: a) bullet hit points less than the target size at any range up to weapons effective range; b) down range profiling up to weapons effective range; c) ranging accuracy sufficient to provide elevation correction; d) automatic ballistic correction; e) day/night operation; and f) no setup or calibration. Additional capabilities could include: increased effective ranges for a wide range of weapons; eye safe ranging; increased ID range during day and night; and shimmer compensation. This program transitioned to the U.S. Army and Marines.<br><br>(U) Leveraging technologies developed under the Crosswind Sensor System for Snipers (C-WINS) program, the Dynamic Image Gunsight Optics (DInGO) program will develop an optical scope that enables a soldier, with minimal training, to shoot a firearm with marksman accuracy. The ability to engage targets at range with a conventional firearm is currently limited by user training rather than the accuracy of the weapon. The technology developed under this program line will enhance a soldier's ability to observe and engage targets at range as well as enhance the capability for close quarters combat. Technical achievements under other programs in this PE/Project provide the basis for radically new approaches to optical scopes, dynamic imaging systems, and low-power video analytics. By extending the capability of combat optics, DInGO enables a soldier to operate at the limit of the system performance with reduced training requirements. Transition to the Army in 2013 is anticipated.<br><br>*FY 2009 Accomplishments:*<br>Crosswind Sensor System for Snipers (C-WINS)<br>- Developed transition and manufacturing plans. | | | | | |

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**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Developed and built one prototype system and integrated and tested system in the lab and field.<br>- Transitioned to the Army and Marine Corps.<br><br>*FY 2010 Plans:*<br>Dynamic Image Gunsight Optics (DInGO)<br>- Perform major system design trades.<br>- Develop a system design for a combat-rifle scope that can be used for close quarters combat as well as to engage targets at distance.<br>- Validate key technology components.<br><br>*FY 2011 Base Plans:*<br>Dynamic Image Gunsight Optics (DInGO)<br>- Fabricate portable brassboard prototype systems. | | | | | |
| Laser Geospatial Referencing (LGR)*<br>*Previously part of Soldier-borne Sensor Technology.<br><br>(U) The Laser Geospatial Referencing (LGR) system investigated technologies to allow ground troops to designate targets for engagement by air forces where the pilot or UAV operator can see the designated spots within the field of view of their visible or forward looking infrared system. The LGR concept looked to provide nearly instantaneous target location, identification and designation capabilities to weapon platforms supporting urban or other ground operations. The LGR concept enables these assets to be immediately directed by dismounted soldiers. Data developed in this program transitioned to the U.S. Army and Marine ground forces and U.S. Air Force.<br><br>*FY 2009 Accomplishments:*<br>- Completed initial feasibility study to determine concept of operations (CONOPS) and design requirements. | 2.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | DATE: February 2010 |
|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-02: *SENSORS AND PROCESSING SYSTEMS* |

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| - Assessed technology development required to meet objectives and developed program plan.<br>- Initiated supporting focal plane array technology development for LGR. | | | | | |
| Foliage Penetration Reconnaissance Surveillance Tracking and Engagement Radar (FORESTER)<br><br>(U) The Foliage Penetration Reconnaissance Surveillance Tracking and Engagement Radar (FORESTER) program developed an ultra high frequency (UHF) ground moving target indicator (GMTI) radar that can detect dismounts and vehicles moving under dense foliage. In the first phase of the program, the FORESTER was installed on a Black Hawk and flown in a series of successful demonstrations in the U.S. and OCONUS. In the second phase of the program, FORESTER was successfully flown on the A160, a revolutionary high-altitude long-endurance unmanned helicopter developed by DARPA and the U.S. Army. FORESTER development concluded with radar field experiments conducted jointly with operational users to refine and optimize FORESTER radar performance and concepts of operation.<br><br>*FY 2009 Accomplishments:*<br>- Conducted radar field experiments and then, based on the results, refined and optimized FORESTER radar performance and concepts of operation.<br>- Transitioning FORESTER to the operational user. | 5.500 | 0.000 | 0.000 | 0.000 | 0.000 |
| Accomplishments/Planned Programs Subtotals | 118.880 | 99.486 | 82.541 | 0.000 | 82.541 |

**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 2011 Defense Advanced Research Projects Agency | | | DATE: February 2010 |
|---|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-03: *EXPLOITATION SYSTEMS* | |

| COST ($ in Millions) | FY 2009 Actual | FY 2010 Estimate | FY 2011 Base Estimate | FY 2011 OCO Estimate | FY 2011 Total Estimate | FY 2012 Estimate | FY 2013 Estimate | FY 2014 Estimate | FY 2015 Estimate | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEN-03: *EXPLOITATION SYSTEMS* | 0.000 | 33.455 | 51.807 | 0.000 | 51.807 | 68.148 | 61.407 | 59.407 | 56.013 | Continuing | Continuing |

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

(U) The Exploitation Systems project develops algorithms, software, and information processing systems to extract information from massive intelligence, surveillance, and reconnaissance (ISR) datasets. In particular, it develops new technologies for detection and discrimination of targets from clutter, classification and fingerprinting of high value targets, localization and tracking over wide areas, and threat network identification and analysis. Efforts will focus on difficult ISR environments, for example (a) urban environments with extensive building obscuration, large volumes of civilian traffic, and feature-rich terrain, (b) mountain environments with highly variable terrain elevation, complex local and regional threat networks, and predominantly dismounted adversaries, and (c) jungle environments with targets under heavy canopy, animal and other sources of clutter masking human activity, and widely dispersed threat activities. The resulting technology will enable operators to more effectively use ISR data in the execution of a wide variety of wide area search, border and road monitoring, high value target tracking, overwatch, and other missions.

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Persistent Operations Surface Surveillance and Engagement (POSSE)* | 0.000 | 11.955 | 13.000 | 0.000 | 13.000 |

*Formerly Persistent Exploitation.

(U) The Persistent Operations Surface Surveillance and Engagement (POSSE) program (previously funded in PE 0603767E, Project SEN-02) is developing the capability to integrate sensor input from multiple modalities to find indications of insurgent activities. Combined with dynamically updated information from soldiers on the ground, POSSE will enable near-real-time generation of the evidence necessary for further investigation or interdiction. POSSE experiments are conducted at the National Training Center (NTC) with realistic role players emulating typical residential, commercial and light industrial activity. Within this environment, insurgent activity is simulated by qualified experts using the latest and most complete intelligence available. Measurements include precision collections of

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | DATE: February 2010 |
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| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-03: *EXPLOITATION SYSTEMS* |

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| insurgent activities, as well as the realistic surrounding background clutter of typical civilian activity. Results will inform future experiments, lead to specifications for future sensor design, and provide insights into how to integrate other narrow and wide area sensors into an integrated approach to countering insurgencies. Transition is planned for U.S. Army Intelligence and Security Command.<br><br>*FY 2010 Plans:*<br>- Conclude the Chemical Detection Experiment series, analyze results, and provide data to inform new sensor designs.<br>- Examine the feasibility of new sensor designs.<br><br>*FY 2011 Base Plans:*<br>- Design and develop new sensors specific to close-in insurgent activity detection.<br>- Demonstrate new insurgent activity detection techniques in field exercises at the National Training Center. | | | | | |
| Foliage Penetrating Radar Planning and Exploitation<br><br>(U) The Foliage Penetrating Radar Planning and Exploitation program will complete final Forester FOPEN radar demonstrations (previously budgeted in PE0603767E, Project SEN-02) and provide further exploitation capabilities to find dismounted targets in densely forested terrain. Current foliage penetrating radar systems provide an important capability for detecting dismount targets under foliage, but the systems also detect animals, moving water, blowing trees, and other scene clutter moving under or in the foliage that makes situation assessment manpower and radar resource intensive. Further, Doppler signature data that experiments indicate may enable improved automated discrimination of dismount targets from other detections is not currently exploited. Finally, no planning tools are available for optimizing and dynamically replanning collection assets to improve imaging geometries and detectability. This program will provide capabilities to address these issues by exploiting Doppler signature data, automating temporal processing approaches currently used, and automating terrain, weather, and on-line exploitation data to enable planning and dynamic replanning. The result will | 0.000 | 5.500 | 8.500 | 0.000 | 8.500 |

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | DATE: February 2010 |
|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-03: *EXPLOITATION SYSTEMS* |

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| be significantly improved capability for finding and localizing targets under foliage. The program will transition to SOUTHCOM and SOCOM.<br><br>*FY 2010 Plans:*<br>- Formulate algorithms for mitigating detections in radar systems due to non-living objects in motion and confusion between humans and animals.<br><br>*FY 2011 Base Plans:*<br>- Evaluate and optimize algorithms for mitigating detections in radar systems due to non-living objects in motion and confusion between humans and animals and develop planning capabilities.<br>- Begin development of planning and dynamic re-planning capabilities. | | | | | |
| Multi-Sensor Exploitation<br><br>(U) The Multi-Sensor Exploitation program continues efforts previously budgeted in PE 0603767E, Project SEN-02 and will provide multi-sensor exploitation capabilities enabling mission overwatch, border surveillance, high value target tracking, and threat network detection using mixes of imaging, radar, signals, human intelligence, and other sources. Key challenges in the first two missions include real-time and wide area dismount and vehicle target detection, discrimination, tracking, and pattern of life analysis. Key challenges in the third mission include tracking through periods of obscuration and confusion in environments in which existing sensors and methods are not able to provide high quality signature data. Key challenges in the fourth mission include discriminating threats from large volumes of civilian clutter and determining the behavior patterns of and relationships between those threats. The Multi-sensor Exploitation program will develop new target tracking methods for wide area motion imaging sensors enabling long duration tracking of vehicles and dismounts through the development of new target dynamic modeling methods, new processing methods tailored to dismounts, and new methods for signature aided tracking. The program will develop new methods for automatically correlating different sources of information to identify threats, estimate threat networks, and analyze behavioral patterns. The program will include a focus on integrated human and machine processing to | 0.000 | 8.000 | 17.900 | 0.000 | 17.900 |

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | DATE: February 2010 |
|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-03: *EXPLOITATION SYSTEMS* |

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| better take advantage of the strengths of each. Technologies are planned for transition to the Air Force, Army, SOCOM, and Intelligence agencies.<br><br>*FY 2010 Plans:*<br>- Create new methods for tracking targets in urban environments leveraging dynamic models motivated by traffic flow theory.<br>- Develop architectures for enabling combined use of multiple sensors, including motion imagery, signals intelligence, and other sources, for threat detection and threat network identification.<br><br>*FY 2011 Base Plans:*<br>- Evaluate and optimize techniques and software for tracking targets in dense target environments.<br>- Develop and test algorithms for combining multiple sensors for threat detection and network identification.<br>- Demonstrate integrated machine-human processing.<br>- Design automated algorithms for high value target tracking in urban environments. | | | | | |
| Target Identification<br><br>(U) The Target Identification program continues efforts previously budgeted in PE 0603767E, Project SEN-02 to develop methods to detect, characterize, and identify targets from both electromagnetic and acoustic sensors. Data sources include national, theater, and organic sensors. Exploiting the acoustic emissions of potential targets is of interest because acoustics do not require an unobstructed line of sight between the emitter and sensor, and under certain circumstances sound may propagate great distances. Critical performance metrics are timeliness, accuracy, error rates, and interpretation workload. The program addresses the challenges of target identification, acquisition, tracking and denial in difficult environments. The technologies will apply advanced signal processing and control to leverage advances in sensor capabilities. Transition is planned to the Navy. | 0.000 | 8.000 | 12.407 | 0.000 | 12.407 |

| Exhibit R-2A, RDT&E Project Justification: PB 2011 Defense Advanced Research Projects Agency | | DATE: February 2010 |
|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-03: *EXPLOITATION SYSTEMS* |

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| *FY 2010 Plans:*<br>- Design and analyze performance of new sensing approaches for target detection and perform limited field testing.<br>- Develop concepts of employment and an overall system architecture, and validate with potential transition customers.<br><br>*FY 2011 Base Plans:*<br>- Develop sensors, mount on surrogate platforms, and field test in realistic operating environments.<br>- Validate concepts of employment, and test overall system via modeling and simulation. | | | | | |
| Accomplishments/Planned Programs Subtotals | 0.000 | 33.455 | 51.807 | 0.000 | 51.807 |

**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 2011 Defense Advanced Research Projects Agency | | | DATE: February 2010 |
|---|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>0400: *Research, Development, Test & Evaluation, Defense-Wide*<br>BA 3: *Advanced Technology Development (ATD)* | R-1 ITEM NOMENCLATURE<br>PE 0603767E: *SENSOR TECHNOLOGY* | PROJECT<br>SEN-CLS: *Classified* | |

| COST ($ in Millions) | FY 2009 Actual | FY 2010 Estimate | FY 2011 Base Estimate | FY 2011 OCO Estimate | FY 2011 Total Estimate | FY 2012 Estimate | FY 2013 Estimate | FY 2014 Estimate | FY 2015 Estimate | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEN-CLS: *Classified* | 0.000 | 39.306 | 28.398 | 0.000 | 28.398 | 46.820 | 38.282 | 28.964 | 38.989 | Continuing | Continuing |

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

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress.

**B. Accomplishments/Planned Program ($ in Millions)**

| | FY 2009 | FY 2010 | FY 2011 Base | FY 2011 OCO | FY 2011 Total |
|---|---|---|---|---|---|
| Classified DARPA Program | 0.000 | 39.306 | 28.398 | 0.000 | 28.398 |
| This project funds Classified DARPA Programs. Details of this submission are classified.<br><br>*FY 2010 Plans:*<br>Details will be provided under separate cover.<br><br>*FY 2011 Base Plans:*<br>Details will be provided under separate cover. | | | | | |
| Accomplishments/Planned Programs Subtotals | 0.000 | 39.306 | 28.398 | 0.000 | 28.398 |

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

N/A

**D. Acquisition Strategy**

N/A

**E. Performance Metrics**

Details will be provided under separate cover.