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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Sensor Technology PE 0603767E				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	167.962	188.781	196.462	219.407	223.535	227.519	230.919	230.919
Surveillance and Countermeasures Technology SEN-01	51.745	54.436	64.725	74.766	76.572	81.556	84.956	84.956
Sensors & Exploitation Systems SEN-02	116.217	134.345	131.737	144.641	146.963	145.963	145.963	145.963

(U) Mission Description:

(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 Exploitation 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) countering camouflage, concealment and deception (CC&D) of mobile ground targets; (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 high value targets.

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(U) <u>Program Change Summary:</u> <i>(In Millions)</i>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Previous President's Budget	186.746	205.519	221.442	219.805
Current Budget	167.962	188.781	196.462	219.407
Total Adjustments	-18.784	-16.738	-24.980	-.398
 Congressional program reductions	 -14.000	 -10.738		
Congressional increases	0.000	0.000		
Reprogrammings	0.000	-6.000		
SBIR/STTR transfer	-4.784	0.000		

(U) Change Summary Explanation:

FY 2006	The decrease reflects the SBIR/STTR transfer and the Section 8040 rescission.
FY 2007	The decrease reflects congressional cuts to SEER, Super-Resolution Vision System, Augmented Aerial Sentry, Bipedal Detection and a reduction for Section 8106 Economic Assumptions and a reprogramming to the Joint DoD/DOE Munitions Program.
FY 2008	The decrease reflects a departmentally directed reduction in funding for the Joint DoD/DOE Munitions Program and completion of several sensors efforts including Frequency-Diverse Spatial/Spectral Sensor Exploitation, Tactical Sensor Network Technologies, and Dynamic Tactical Targeting.
FY 2009	The decrease reflects minor program repricing.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Sensor Technology PE 0603767E, Project SEN-01				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Surveillance and Countermeasures Technology SEN-01	51.745	54.436	64.725	74.766	76.572	81.556	84.956	84.956

(U) Mission Description:

(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 covert 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.

(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
Counter Underground Facilities (UGFs)	14.208	22.218	26.725	32.766

(U) Counter Underground Facilities (UGFs) are being increasingly employed to hide a variety of tactical and strategic functions, including command and control, leadership escapes and hides, missile and artillery protection, and activities associated with the manufacture and storage of weapons of mass destruction. The Counter-Underground Facilities (CUGF) program is developing technologies to both find and characterize UGFs: identification of facility function, pace of activity, pre-attack status of the facility, trans-attack activities and post-attack status. Techniques are being developed to determine locations of critical systems (power, water, airflow and exhaust vents), orientation and depth of structure, and pre-strike and post-strike changes in the substructure resulting from attack.

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(U) This program began by developing validated phenomenological models for a range of underground facilities (UGF) signatures: acoustic, seismic, electromagnetic (EM), chemical, multi/hyperspectral, and gravity/gravity gradient. These models enable the evaluation of multiple sensor/targeting concepts, and drive requirements for highly sensitive, advanced sensors, which operate at very low frequencies in order to reach deeply buried structures. The CUGF Unattended Ground Sensor System (CUGSS), demonstrated the use of multiple, networked ground nodes of multi-phenomenological sensors (EM, acoustic, seismic) for UGF monitoring and target characterization. Another element, Effluents for Vent Hunting, has evaluated the feasibility of finding vents from stand-off locations by exploiting the spatial, spectral, and temporal characteristics of the exhaust plumes. The Low-Altitude Airborne Sensor System (LAASS) is demonstrating the use of airborne EM, acoustic, and gravity sensors to rapidly find UGFs and map out their backbone structure. Techniques are also being developed for finding and mapping traces and portals of small tunnels used for movement among large facilities or buildings, and for surreptitiously crossing borders and security boundaries. The Cross-Border Tunnel (CBT) program is using seismic and electromagnetic tomography to detect and localize small tunnels. The Remote Interconnected Tunnel Assessment (RITA) program demonstrated stand-off hyperspectral sensing to determine portals and vents that are connected by tunnels underground. Other potential technologies to be included are precision thermal imaging and active surface seismic and electromagnetic approaches. These are particularly useful for small, relatively shallow, unimproved tunnels.

(U) To support the demonstrations of these concepts, the CUGF program is also developing or modifying E-field, B-field, acoustic, and gravity-based sensors and enhancing navigation communications and signal-processing systems and technologies as necessary to meet the node-localization, communications and data-exfiltration requirements. The CUGF technologies began transition to the United States Special Operations Command, Defense Threat Reduction Agency (DTRA), the Defense Intelligence Agency (DIA), the Army, and the Air Force in FY 2006 and will continue transition through the FY 2010 time frame.

(U) Program Plans:

- Transitioned CUGSS technology to DTRA, Air Force, DIA, and the Army.
- Demonstrated RITA technology at a U.S. military facility.
- Transitioned RITA-Lite system to the U.S. Army Rapid Equipping Force.
- Build test bed for evaluation of CBT and other CUGF technologies.
- Develop designs and performance predictions for prototype LAASS sensor payloads (EM, acoustic, and gravity) for unmanned air vehicles (UAVs) and manned aircraft platforms.
- Integrate LAASS sensor payloads onto low-altitude UAV and manned aircraft platforms and develop optimum flight pattern strategy.

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- Demonstrate LAASS prototype system in rural and urban environments.
- Develop and demonstrate small tunnel finding, localizing, and endpoint mapping capabilities of prototype, rapidly transitionable systems in the CBT and RITA programs.

	FY 2006	FY 2007	FY 2008	FY 2009
Strategically Hardened Facility Defeat	0.000	4.000	6.000	9.500

(U) Building upon the successes of this 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 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 seeks to leverage recent advances in earth-penetrating technologies for full defeat of strategically hardened facilities. This program will transition to DTRA in FY 2011.

(U) Program Plans:

- Develop new penetration technologies capable of meeting deployable weight and size goals.
- Develop robust, self-contained aerial deployment options that can interface with existing air platforms.
- Develop the ability to sense and navigate to the targeted functional area.
- Develop packaging and integration technologies that can withstand harsh environments.

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	FY 2006	FY 2007	FY 2008	FY 2009
Visibuilding	7.030	11.218	15.000	16.000

(U) The Visibuilding program is developing technologies and systems for new surveillance capabilities of buildings, to detect personnel within buildings, to determine building layouts, and to locate weapons caches and shielded enclosures within buildings. 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 also allow mapping of building pathways and stairways by monitoring traffic through buildings. Doppler resonances of the building structure are being examined to provide relevant mapping information and indications of floor loading. 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. This program is developing techniques to inject and recover probing waveforms and to unravel the complicated multipath in the return signals, to enable the mapping and characterization of buildings. Transition of component pieces to the Army's PEO Soldier and United States Special Operations Command will commence in FY 2009.

(U) The Radar Scope program is a quick-response effort to provide pre-production prototypes of hand-held through-wall personnel detection radar. It will be able to sense through common wall materials to detect potential enemies before warfighters enter a room or building. The final product is a small sensor with a simple interface that weighs less than two pounds including batteries. The unit detects individuals through typical non-metallic wall materials (e.g., concrete, concrete block, adobe, wallboard, plywood, etc.) up to twelve inches thick. Transition to the Army Rapid Equipping Force via PEO Soldier Sensor and Lasers is anticipated. Follow-up technologies have been requested for sniper self defense, tunnel inspection, perimeter defense, remote operations, and finding objects buried in walls.

- (U) Program Plans:
- Visibuilding
 - Evaluated candidate designs for wall-penetrating technologies for building layout and combatant localization.
 - Evaluate candidate technical approaches for monitoring building envelope integrity.
 - Evaluate technical approaches for building interconnects detection and assessment.
 - Carry out feasibility measurements and modeling.

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- Design, build, and test prototypes for use in full-scale demonstration.
- Radar Scope
 - Evaluated candidate designs for through wall motion detection.
 - Carried out feasibility measurements and modeling.
 - Designed, built and tested prototypes for use in full scale demonstration.
 - Transition for use in full-scale demonstration.
 - Develop extensions of this technology for new application areas.

	FY 2006	FY 2007	FY 2008	FY 2009
Surveillance and Threat Neutralization in Urban Environments	3.000	9.000	7.000	3.000

(U) This program will develop systems to demonstrate the detection and defeat of threats specific to conflict and stabilization operations in the urban environment. These threats include roadside bombs, car bombs, suicide bombers, snipers, rocket propelled grenades, and mortars launched from inside urban boundaries. Detection technologies under development include intercept and localization of unintentional radiated emissions of remote-control circuits; multi-static radars for standoff identifications of shrapnel-packed bombs; detection of anomalies in vehicle dynamics; standoff identification and localization of explosive vapors/effluents; high fidelity 3D mapping performed from a high altitude (>15,000 feet) airborne platform; and multi-mode integrated acoustic and radar-based systems to backtrack to the source of fire. Techniques to cause incomplete detonation of explosives; portable fast-erecting blast shields and technologies to non-destructively and reversibly control urban access routes are being explored. These capabilities will be transitioned to Army and Special Operations ground forces to support urban operations planning with an initial focus on the targeting and intelligence components in FY 2009.

- (U) Program Plans:
- Evaluate candidate technologies for wide-area/stand-off and choke-point/portal-screening applications.
 - Prove feasibility in lab on sub-scale tests.
 - Design, build, and test prototype for choke-point applications and wide-area applications.

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	FY 2006	FY 2007	FY 2008	FY 2009
Integrated Sensor Is Structure (ISIS)	18.000	0.000	0.000	0.000

(U) The Integrated Sensor Is Structure (ISIS) program is developing a sensor of unprecedented proportions that is fully integrated into a stratospheric airship and that will address the nation's need for persistent wide-area surveillance, tracking, and engagement for hundreds of time-critical air and ground targets in urban and rural environments. ISIS is achieving radical sensor improvements by melding the next-generation technologies for enormous lightweight antenna apertures and high-energy density components into a highly-integrated lightweight multi-purpose airship structure – completely erasing the distinction between payload and platform. The ISIS concept includes 99% on-station 24/7/365 availability for simultaneous Advanced Moving Target Indicator (AMTI) (600km) and Ground Moving Target Indicator (GMTI) (300km) operation; 12-plus months of autonomous, unmanned flight; hundreds of wideband in-theater covert communications links; plus CONUS-based sensor analysis and operation. The ISIS technology is planned for transition to the Army's PEO-ASMD, Air Force Joint Warfighter Space and the Missile Defense Agency by FY 2011. This program now resides in PE 0603287E, Project SPC-01.

(U) Program Plans:

- Developed objective system concept designs enabling simultaneous AMTI and GMTI operation, one year logistics-free operation, 99% on-station availability, and high-bandwidth covert communications.
- Identified specific mass-reducing technologies for key radar, power, and airship components.

	FY 2006	FY 2007	FY 2008	FY 2009
Radiation Detection (Formerly NUCTRAC)	3.000	0.000	0.000	0.000

(U) The Radiation Detection program investigated new technologies and systems to advance and enhance DoD capabilities in the area of hostile nuclear activities. In particular, this program considered technologies to improve radiation detection and tracking.

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- (U) Program Plans:
- Completed initial technology assessment.

	FY 2006	FY 2007	FY 2008	FY 2009
Hostile Fire Indicator (HFI)	3.957	2.000	0.000	0.000

(U) The Hostile Fire Indicator (HFI) program will develop an airborne extension of the Boomerang Rapid Response program to provide rotorcraft with situational awareness of small arms fire. Currently, pilots may be unaware that they are receiving small arms fire until it impacts in the vicinity of the crew cabin or some other critical and monitored system. The HFI system was initially designed to detect and locate the source of any small arms projectiles passing within meters of aircraft with a high probability of detection and precise source-location accuracy.

- (U) Program Plans:
- Measured acoustic/vibrational frequency background noise on one U.S. Army and two SOF helicopters.

	FY 2006	FY 2007	FY 2008	FY 2009
Speckle Exploitation for Enhanced Reconnaissance (SEER)	0.000	4.000	7.000	8.500

(U) The Speckle Exploitation for Enhanced Reconnaissance (SEER) program will provide 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 should provide a viable signal at ranges exceeding those projected for other active laser systems. Technical achievements under other programs in this PE/Project provide the basis 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 enables 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. Transition to the Army is expected to occur by FY 2012.

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- (U) Program Plans:
- Develop algorithms that reliably and uniquely associate target signatures with speckle patterns.
 - Perform major system design trades.
 - Implement algorithms using optical MEMs or other related technologies to achieve reduced size, weight and power.
 - Design, develop, field, and test a prototype system on a tactical vehicle.

	FY 2006	FY 2007	FY 2008	FY 2009
Rescue Transponder	2.000	2.000	0.000	0.000

(U) Building upon technologies developed in other sensor programs, the Rescue Transponder (RT) program will investigate the use of covert localization and tracking technology to provide a very low probability of detection (LPD) call for help signal. The system is expected to 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 Rescue Transponder technology is planned for transition to the Army in 2007.

- (U) Program Plans:
- Developed tags that enable the user to be identified and localized by airborne or advantaged receivers.
 - Designed a custom digital and microwave integrated circuit to allow tag miniaturization.
 - Built and tested prototype tags and transmitters.
 - Author viable manufacturing plans.
 - Conduct airborne demonstration and complete interference and LPD assessment to demonstrate military utility to transition partner.
 - Complete transition MOA between DARPA and Army.

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	FY 2006	FY 2007	FY 2008	FY 2009
Bioluminescent Signature Reduction	0.000	0.000	3.000	5.000

(U) Turbulence from vessels moving through the water stresses dinoflagellates and other single and multi-cell organisms causing them to emit light. This bioluminescent effect is readily visible under favorable circumstances providing a signature of the moving vessels. The goal of the Bioluminescent Signature Reduction program is to mitigate this effect through both inhibition of bioluminescence processes and masking of bioluminescent emissions. This new effort will include development of inhibition and masking technologies, bioluminescence sensors, delivery mechanisms for the mitigation technologies, and sea trials for testing the prototype system. Additionally, there will be continued development of a bioluminescence signature model, which is an empirically-based, time-dependent detectability model (range, cell concentration, and environmental). Recent developments in characterization of bioluminescent organisms and materials technology will be leveraged by the performer community in meeting the goals of this program. Transition partners may include the SOCOM Program Executive Office, Naval Systems, and the Special Naval Warfare Command.

(U) Program Plans:

- Explore prospective mitigation strategies involving engineering, materials, and concepts of operation.
- Develop detectability model for bioluminescent emission visualization.
- Identify and validate material approach for bioluminescent masking.
- Develop bioluminescence process inhibition technologies.
- Incorporate advanced algorithms into detectability model development.
- Develop system component concepts for countermeasure delivery and monitoring sensors.
- Integrate technology development, sensor, and modeling prototypes into a full-scale prototype system.
- Conduct sea trials and demonstration of the prototype system.

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	FY 2006	FY 2007	FY 2008	FY 2009
RF MEMS Improvement	0.550	0.000	0.000	0.000

(U) RF MEMS switches in the X, Ka, and Ku band hold great promise for DoD radar applications due to their inherent small size, light weight, low power consumption and low loss. The RF MEMS Improvement program has extended lifetimes, developed inexpensive packaging techniques, and enhanced RF performance of RF MEMS switches to allow use in devices such as phase shifters, reconfigurable apertures, and tunable filters. The RF MEMS Improvement program is transitioning via industry to phased array antenna, reconfigurable communication front-end, seeker, and steerable aperture programs being developed by the Army, Navy, and Air Force.

(U) Program Plans:

- Demonstrated fully integrated switch circuits (e.g., fully integrated phase shifters, switchable filters) with substantially better performance than discrete switch approaches.
- Demonstrated integration of RF MEMS switches together with integrated transistor circuits to realize compact, single-chip systems.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Sensors & Exploitation Systems SEN-02	116.217	134.345	131.737	144.641	146.963	145.963	145.963	145.963

(U) Mission Description:

(U) The Sensors and Exploitation Systems project develops and demonstrates advanced sensor and exploitation technologies to provide accurate situational awareness and precise target identification. The project is driven by five needs: (a) integrating data from multiple sources into consistent situation assessments; (b) countering camouflage, concealment and deception of mobile ground targets; (c) providing near-real-time semi-automatic exploitation of wide-area moderate- and high-resolution imagery; (d) obtaining real-time, accurate battle damage assessment; and (e) accomplishing robust, precise identification, precision fire control tracking and engagement of ground targets. These needs are addressed in eight thrusts: 1) Soldier-borne Sensor Technology, to improve individual soldiers' situational awareness and effectiveness; 2) Ground Targeting Sensors, to increase our ability to detect close-in ground targets; 3) Advanced Airborne Optical Sensing, to provide high-resolution images over large areas; 4) Advanced Radar Sensing Technology, to observe targets at night and in bad weather; 5) Target Identification Technology, to build tools to automatically identify targets; 6) Pattern Analysis Technology, to distinguish suspicious movement and activity from benign clutter; 7) Network Centric Sensing and Engagement, to explore novel processing architectures enabled by the proliferation of data links; and 8) Persistent Exploitation, to combine sensors and exploitation tools in an integrated system to address counter-insurgency missions.

(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
Soldier-borne Sensor Technology	16.245	15.273	14.465	13.000

(U) The Soldier-borne Sensor Technology thrust provides sensors for improved situational awareness and effectiveness of individual soldiers. It builds small unit enemy weapon fire detection and classification tools, more precise target designation sensors, and methods for improved small arms weapon effectiveness. Programs in this thrust include:

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- The High Precision Long Range Laser Designator/Locator (HPLD) program seeks to develop an affordable laser target designator/locator package that allows the user to observe, track, and designate a target at operationally significant ranges. The focus of this effort is to investigate target-in-the-loop active optics approaches and novel high accuracy pointing methods to enable a single operator to precisely determine the GPS coordinates of a target that is multiple kilometers away. Once precisely determined, the operator will be able to observe, track, and laser designate the target as required, using a single device. This device will be used by ground combat elements and small unmanned aerial vehicles that conduct terminal attack control and call for fire and will be designed to support their full range of deployment methods. It will also survive in a harsh environment for long periods of time with minimal maintenance. This program will also investigate advanced, lightweight inertial navigation system (INS) technology, infrared imaging and advanced on-focal-plane processing technology to achieve revolutionary improvements in targeting device form factor, speed, cost and accuracy. The High Precision Long Range Designator/Locator technology is planned for transition to the Army and U.S. Special Operations Command (SOCOM) by FY 2009.
- The Omni-Directional Flash & Launch Detection, Positioning, Classification and Observation System (MEGA) program will develop a low-cost, omni-directional staring, infrared sensor, which will provide circumpheral imagery of its surroundings. The MEGA sensor and algorithms will be used to detect weapon discharges in its field of regard, locate and classify them and, using appropriate communication means, convey the information to other units or systems connected to it. This program will transition through delivery of two final 360 degree mobile systems to Service partners.
- The Crosswind Sensor System for Snipers (C-WINS) program provides optical techniques to correct for crosswinds on ballistic objects. The C-WINS System develops a novel weapon mounted laser correction system for various rifles and machine guns. This laser will be directed downrange for wind profiling and ballistic correction. The new system will provide offset corrections to the shooter for compensating the aim point affected by the crosswind. Key parameters of interest are: a) bullet strike coordinates 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 offset; 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; illumination when combined with night sight; combat ID; and point-to-point voice communications. This program is planned for transition to the Army and Marines in 2010.

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- (U) Program Plans:
- High Precision Long Range Designator/Locator
 - Built and demonstrated target-in-the-loop adaptive optics ability to achieve high resolution laser pointing and imaging of small targets.
 - Validated the pointing accuracy of eye safe integrated optics at targets multiple kilometers away.
 - Design, build, and demonstrate an integrated system of low weight and volume that validates the ability to be deployed and erected by dismounted troops.
 - Omni-Directional Flash & Launch Detection, Positioning, Classification and Observation System (MEGA)
 - Develop and demonstrate IR sensor prototype.
 - Develop and demonstrate stationary omni system.
 - Develop and demonstrate mobile platform omni system.
 - Integrate mobile system with vehicle and demonstrate in series of field tests.
 - Crosswind Sensor System for Snipers (C-WINS)
 - Develop atmospheric turbulence statistical model and investigate commercial off-the-shelf (COTS) lasers to test concept feasibility by modeling and field testing.
 - Develop system concepts that rely on tracking the aerosol motion resulting from crosswind over time.
 - Design and build an electronics board sufficient to trigger laser at required rates, receive, store and process data (on line and offline).
 - Integrate system and conduct field tests to validate the proposed concept as a function of the crosswind and scintillation index.
 - Develop and build three prototype C-WINS systems and integrate and test system in the lab and field.
 - Develop transition and manufacturing plan.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor Technology PE 0603767E, Project SEN-02	

	FY 2006	FY 2007	FY 2008	FY 2009
Ground Targeting Sensors	0.000	10.759	17.540	22.102

(U) The Ground Targeting Sensor thrust provides sensors and signal processing systems to detect, identify, and engage close-in ground targets. Its products are installed on platforms that operate on the ground (HUMVEE, convoy elements) and near the ground (helicopters). They employ technologies that defeat or compensate for the unusual atmospheric conditions near the surface (turbulence, dust, strong propagation losses) in order to provide timely and accurate detection and classification of dismounts, small vehicles, and terrain obstacles. Programs in this thrust include:

- The SandBlaster program is developing a passive pilot enhancement system that fuses visible, infrared (IR) and millimeter wave radiation to enable multiple helicopters to land safely in conditions of severe brown- and white-out. SandBlaster will exploit the low attenuation property of dust (fog and snow) on millimeter wave radiation. A passive millimeter wave system will be developed to preclude detection and prevent interference as would be expected from multiple active systems operated in close proximity. Four fundamental piloting situational awareness enablers will be addressed: (1) pilot's ability to "see" in limited visibility conditions, (2) pilot's awareness of helicopter drift, (3) pilot's awareness of slope of terrain, and (4) display technology matched to mission and human factors considerations. The technology developed under this program will transition to SOCOM and the Marine Corps in FY 2008.
- 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 better than diffraction-limited images. 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. Technology developed under this program will transition to the Services in 2010.

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- Polar Bear will provide a missile seeker that uses polarimetric processing and 3-D registration with target folders to generate precision terminal guidance. The system will sense polarimetric long-wave infrared signals generated by target and background, derive the surface shapes of the target and background and match the target shape to 3-D target folders. This will enhance target identification capabilities and enable precision aim-point selection on the target. The program will develop algorithms for surface normals and shape signature extraction from polarimetric data, develop tools for 3D target folders, and develop software for real time onboard processing. The precision attainable by Polar Bear will be suitable for a kinetic-kill weapon and the sensor cost will be comparable to existent uncooled infrared missile sensors. Technologies are planned for transition to the U.S. Army.
- The Short Wave Infrared through Fog (SWIF) program will develop and demonstrate advanced signal processing and optical imaging technology to allow detection of collision and grounding threats in fog at useful ranges (day or night). Fog substantially degrades performance in precision handling operations. Humans are able to operate successfully with sensor assistance, but situational awareness degrades significantly with fog. Successful development of this technology will restore this situational awareness to tactically relevant distance and time scales. Technology developed under this program will transition to the Navy in 2012.

- (U) Program Plans:
- SandBlaster
 - Tested attenuation properties of dust on active and passive millimeter wave imaging and developed system requirements.
 - Develop and identify an end-to-end system to provide the pilot with required situational awareness to land safely in multi-platform operations.
 - Integrate the system and demonstrate capabilities.
 - Super-Resolution Vision System (SRVS)
 - Investigate optimal control algorithms and implementation using optical MEMs and chip-based technologies.
 - Perform system design.
 - Design and develop a brassboard prototype for laboratory and field experimentation and developmental testing.
 - Integration into a prototype soldier-portable optical system.

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- Polar Bear
 - Conduct long-wave infrared measurements of various targets over a range of employment conditions, including geometry, lighting, obscurants, etc.
 - Develop and evaluate polarimetry-based 3-D registration algorithms.
 - Develop algorithms and exploitation tools for target folder development based on processed sensor data.
 - Conduct preliminary design review for a Polar Bear enabled missile seeker to be built and demonstrated.
 - Develop a concept for operations and identify transition opportunities for the Polar Bear seeker technology.
- Short Wave Infrared through Fog (SWIF)
 - Develop and demonstrate imaging algorithms.
 - Demonstrate image formation capability in a brassboard system.
 - Design, develop, and test a prototype system.

	FY 2006	FY 2007	FY 2008	FY 2009
Advanced Airborne Optical Sensing	19.700	26.389	25.100	26.000

(U) The Advanced Airborne Optical Sensing thrust develops large aperture sensors and image processing systems to provide video coverage of large areas. It builds optics, gigapixel focal plane arrays, embedded image processors, and video compression algorithms tailored to real-time detection, identification, and tracking of military targets. It emphasizes materials and phenomenologies suitable for operations at night and with significant atmospheric absorption. Programs in this thrust include:

- 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 (>10km). The SPI-3D sensor overcomes obscuration and penetrates foliage, camouflage, and fog layers via range gating and control of incident pulse energy density. 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-3D precision ID capabilities and track fusion techniques. The objectives are to provide: (1) high range resolution imaging; (2)

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intensity mapping; and, (3) polarization exploitation. Results will provide commanders with significantly improved long-range identification of enemy ground targets, both stationary and moving. The SPI-3D sensor system employs existing commercial-off-the-shelf optics, focal plane arrays and gimbals, combined with a novel Pockels cell range measurement technique. The SPI-3D technology is planned for transition to the Air Force at the conclusion of Phase IV, which is anticipated to be completed by FY 2010.

- The Synthetic Aperture Ladar for Tactical Imaging (SALTI) program develops and demonstrates an airborne synthetic advanced laser radar (ladar) imager capable of producing high-resolution three-dimensional imagery at long ranges. The SALTI approach combines the long-range day/night access afforded by conventional synthetic aperture radar with the interpretability of high-resolution optical imagery and the exploitability of three-dimensional imagery, for deployment within a tactical-sized package. The technical objective of the SALTI program is to provide a proof-of-concept for operation at tactically relevant high altitudes and at long ground ranges. Development and demonstration of long range performance is scheduled to be conducted through FY 2009. The SALTI technology is planned for transition to the Air Force by FY 2010.
- The Advanced Optical Sensing program develops the next generation of airborne optical surveillance systems while also developing and demonstrating the ability to obtain very high dynamic range, high resolution hyper-spectral and polarimetric information from airborne imagers. The program focuses on bringing recent advances in photonic and other technologies to military airborne optical sensing systems. This effort develops advanced digital signal processing to support onboard image reconstruction, atmospheric correction and system calibration. Techniques are being explored to realize a large aperture wide-field-of-view imaging system within less than half a meter of thickness. Adaptive optics techniques, such as those used for atmospheric correction, are being explored to help combine sub-apertures while relieving alignment requirements. While electronic beam steering and zoom optics have been demonstrated with deformable mirrors and liquid crystal spatial light modulators, this program seeks to extend these technologies and make them practical for airborne surveillance systems. Technologies are planned for transition to the U.S. Army.
- The Large Area Coverage Search-while-Track and Engage (LACOSTE) program enables persistent tactical-grade Ground Moving Target Indication (GMTI) 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 electroptical infrared system. The LACOSTE program will provide wide area surveillance, simultaneous tracking, and target engagement with optical and infrared sensors for tactical GMTI operations. The program is developing

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a sensor with a very wide field of regard (90° 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 (~100) targets in dense urban areas within that same field of regard with a 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 Air Force and the Army at the conclusion the program anticipated in FY 2009.

(U) Program Plans:

- Standoff Precision ID in 3-D (SPI-3D)
 - Determined precision of ranging technique in a field environment.
 - Integrate and demonstrate system from manned aircraft against stationary and moving targets.
 - Conduct confirmatory tests to demonstrate utility of the SPI-3D sensor system under a wide range of environments and target conditions.
 - Integrate SPI-3D technologies into a unmanned air vehicle (UAV) compatible prototype system.
 - Transition SPI-3D sensor technologies and system concept to the Services.
- Synthetic Aperture Ladar for Tactical Imaging (SALTI)
 - Completed sensor packaging and ground testing.
 - Completed Early Flight Tests, which produced the first-ever Synthetic Aperture Ladar high-resolution image images from aircraft.
 - Refined image formation processing algorithms to coherently combine multiple laser pulse returns and to compensate for platform motion during the collection of these multiple pulses.
 - Characterize coherent infrared propagation through the atmosphere under operational conditions, to assess the feasibility of long range operation.
 - Develop lasers for higher power and higher bandwidths to support Long Range Demonstration (LRD).
 - Demonstrate, in LRD, SALTI performance at operationally significant ranges on contractor-owned airborne testbed.

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- Advanced Optical Sensing
 - Investigate approaches for producing large aperture imaging systems with constrained size.
 - Explore uses of adaptive optics to provide optical corrections for multiple sub-apertures.
 - Investigate technologies for optical beam steering and optical zoom that can be applied to airborne optical systems.
 - Develop advanced signal processing techniques for the rapid formation of optical imagery.
 - Design, build and demonstrate next generation airborne surveillance system.
 - Incorporate state-of-the-art automatic target recognition capabilities into a chosen system.
 - Transition system to Services for production and fielding.
- Large Area Coverage Search-while-Track and Engage (LACOSTE)
 - Develop objective system concepts enabling wide-area stand-off sensor for urban tactical-grade ground target tracking.
 - Develop electrophotical infrared electronically scanned sensor components.
 - Develop optical tracking algorithms.
 - Lab test the sensor parameters against measured urban data.
 - Manufacture and integrate the LACOSTE sensor components.
 - Conduct a rooftop demonstration of a large cone-angle electronically scanned sensor in an urban environment.

	FY 2006	FY 2007	FY 2008	FY 2009
Advanced Radar Sensor Technology	8.000	12.000	15.000	20.000

(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 radar sensing technology and phenomenology. Key elements are advancements in ultra-wide band, bistatics, UHF/VHF, polarimetric change detection, tomographic imaging, space-time adaptive processing and other advanced signal processing, advanced Ground Moving Target Indication techniques, and foliage, building-penetrating, and ground-penetrating radar phenomenology. Program developments are integrated with current and emerging military platforms. Emphasis is on the most stressing military radar sensor challenges. Examples are operations featuring

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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:

- The Augmented Aerial Sentry (AAS) program develops a rapidly-deployable airborne system to provide assured protection of permanent or temporary U.S. base camps in hostile territory. AAS includes ground-based, wide area sensors in conjunction with air platforms to maintain continuous surveillance of the area around the camp, detecting potential intruders or weapon launches. The suite of airborne sensor platforms can be tasked locally to investigate potential threats; lock on to personnel or weapons involved in an attack; allow commanders to confirm threats; or authorize precision weapons to engage them. Technologies are planned for transition to the Air Force and Army.
- The Sensing and Exploitation of Urban Movers (SE-UM) (formerly Bipedal Detection) program develops technology for the detection of dismounted troops in combat situations using airborne radars. SE-UM develops the capability to detect, classify, track and recognize the behavior of human beings using radar data. Existing radars that have been shown to allow this capability under ideal circumstances; those under development will, either fortuitously or by design, more consistently obtain detections from individuals. SE-UM will exploit these data by detecting each individual, classifying the individual as human and according to their speed and gait, tracking many individuals (forward and backwards in time) and automatically recognizing common, anomalous and significant actions/behaviors. Challenges include detection of motion below the minimum discernable velocity of the radar system, and discernment of multiple moving objects within a single beam width. Using SE-UM on data from appropriately designed airborne radar the system could observe human motion over an entire urban region. SE-UM technologies will transition to the airborne systems deployed by the Air Force and Navy.
- The NetTrack program will extend capabilities for persistent tracking and targeting of moving vehicles from airborne radars. NetTrack will improve capabilities in two ways: the system will network radars together and use advanced radar techniques to gather “signatures” of vehicles. The signatures, which are collections of radar features, will be stored and passed over the radar network. The system will compare vehicle signatures taken before and after confusing events to maintain the track of the target vehicles. Extended long-term airborne radar tracking will be an important long-range, all-weather, capability. It will extend the kill chain to enable vehicle engagement hours after target designation, enable behavioral analysis of vehicle movements to gauge enemy operational structure, force composition, and intentions, and provide a higher level of situational awareness at every level. Technologies are planned for transition to the Navy, Army and Air Force.

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- The Dual Beam Lynx program will enhance the capabilities of the Lynx radar system to track slow-moving vehicles more accurately. The program modifies a Lynx I radar to create two beams with different phase centers and uses space time adaptive processing to detect moving targets in the main beam clutter. The goals of this program include demonstrating improvement in minimal detectable velocity, improving geolocation accuracy, and achieving a low manufacturing cost. The radar performance will be demonstrated from flight data collected from the radar flying on a UAV surrogate.

(U) Program Plans:

- Augmented Aerial Sentry
 - Develop system architecture that will utilize existing and newly-developed sensing technologies to track potential and imminent threats.
 - Demonstrate effectiveness of system architecture.
 - Develop, demonstrate, and test system that incorporates multiple sensing technologies to provide situational awareness to commanders.
- Sensing and Exploitation of Urban Movers (SE-UM)
 - Develop algorithms to extract and classify dismount combatants walking, running, and other repetitive activities based on collected data.
 - Develop and evaluate algorithms for classifying human activities, e.g. walking, running, digging, carrying loads, etc.
 - Develop and evaluate algorithms for feature-aided tracking of dismounts based on characteristic signatures, e.g. gait parameters, human height, etc.
 - Develop concepts for operation and system architectures for the insertion of SE-UM modes into existing and future planned radar systems.
- NetTrack
 - Improve capabilities for using vehicle radar signatures to associate vehicle observations.
 - Demonstrate NetTrack operations in simulation.
 - Demonstrate radar signature-aided vehicle tracking, and the cooperative use between radar platforms of those radar features.
 - Demonstrate NetTrack capabilities in real-time on networked radar platforms.

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- Dual Beam Lynx
 - Conduct Preliminary Design Review.
 - Develop algorithms.
 - Develop space time adaptive processing.
 - Perform flight test and data collection.

	FY 2006	FY 2007	FY 2008	FY 2009
Target Identification Technology	16.998	17.000	17.000	20.000

(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. 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. Programs in this thrust include:

- The Tactical Sensor Network Technologies (TSNT) program develops detection, tracking, identification, and pattern analysis capabilities that operate in all nodes (fixed or mobile) within a networked, distributed multi-sensor system. The processing to be performed at each network node depends on the sensors reporting to that node, the subscribing commanders, and resource management decisions. TSNT exploits locality of sensing, but will leverage the advantages of a self-forming adaptive network for signal processing. Algorithms are designed to be aware of the sensor network and adapt their processing algorithms based on self-discovered network topology. The algorithms also take into account power management constraints, communications bandwidth limitations, and constraints found in the local environment. TSNT is resilient to the failure of any node while maintaining sufficient consistency to support commanders' collaborative tactical planning. Technologies are planned to be transitioned to the U.S. Army (PEO IEWD).
- The Exploitation of 3-D Data (E3D) program has developed techniques for rapidly exploiting 3-D sensor data. The initial program effort consisted of three distinct processes: Target Acquisition, Target Recognition, and Modeling. The resulting software tools were integrated into operational ground stations processing 3-D sensor data. The E3D technology was transitioned to SOCOM in FY 2006. The 3D

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Reasoning (3DR) initiative is a follow-on program to E3D which will develop techniques to automatically generate large, fully annotated 3D urban models from the rich sources of high-resolution laser radar data available from ground-based and airborne platforms. 3DR extends vehicle-centric automated target recognition methods to support the much broader class of objects accessible in urban and complex terrain - particularly side-looking sensors mounted on patrol vehicles. The program consists of four distinct components: (1) new methods to rapidly and precisely co-register 3D and 2D data from disparate ground and airborne sources; (2) new 3D recognition approaches that identify objects within a class based on limited initial training; (3) a flexible and expandable 3D database structure to support the highly detailed and evolving urban models and provide the basis for geometry-based queries; and (4) a user interface that provides rapid and flexible access to the data. The resulting software tools and modeling capabilities will be integrated into future command posts and operational SOCOM and Army units in the field at the conclusion of the program anticipated to be completed in FY 2011.

- The All-Source Target Characterization program develops a collection and measurement capability to characterize new targets as they emerge on the battlefield. This effort develops tools to permit rapid user interaction with imagery, sensor data, and processing results and provides real-time feedback to operators indicating target key features and other discriminates. The technology provides tools to process and disseminate target signatures to the field in usable formats for direct insertion into operational systems and enhances operator interfaces with extant analysis workstations to allow on-the-fly collection of signature data with little/no intervention for the operator. Technologies are planned for transition to the Air Force Distributed Common Ground Station in FY 2009.
- The Detect UAV program develops techniques to detect, track, and characterize small UAVs that are easily built, inexpensive, easy to operate, and offer the asymmetric adversary an ability to reach into well-defended locations causing potentially large amounts of damage. It includes signal processing techniques to detect small air targets in radar, video, acoustic, and passive radio-frequency intercepts; 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 Army in FY 2010 to meet both static force protection needs and tactical air defense operations.

(U) Program Plans:

- Tactical Sensor Network Technologies (TNST)
 - Develop algorithms for distributed situation assessment at all nodes of a networked group of sensors.

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- Integrate and assess distributed system performance in large-scale simulation and limited-scale testing.
- Demonstrate robustness of TSNT networked sensing under network and environmental stresses.
- Incorporate tracking, target identification, and target assignment algorithms for fully distributed operation.
- Exploitation of 3-D Data (E3D)
 - Integrated E3D software into a fingerprinting system capable of identifying specific vehicle instances.
 - Extended model-based vision technologies to classify, identify, and characterize the operational state of ground targets from other sources of 3-D sensor data.
 - Provide high-resolution ground-based data sources to develop cross-platform data registration algorithms.
 - Develop new recognition algorithms to locate, identify, and annotate objects based on class properties.
 - Incorporate intelligent character recognition for sign reading in urban areas aided by 3D extraction methods.
 - Expand class recognition algorithms to hundreds of classes of objects in urban and complex terrain.
 - Improve processing time to fully annotate several square kilometer models in less than an hour.
 - Integrate natural language interface to allow warfighters to quickly access urban models with detailed queries.
- All-Source Target Characterization
 - Obtain a large set of target vehicles of extreme variety.
 - Characterize the shape, surface material, equipment, and mobility characteristics.
 - Obtain data on all vehicles in a scripted scenario representative of future threat operations.
 - Release data for a baseline set of vehicles to develop target models.
 - Conduct quarterly characterization exercises given a fixed time to develop a new set of target models from observed data.
 - Evaluate performance by comparing reconstructions with the shape, surface material, equipment, and mobility characteristics measured on the actual vehicles.
- Detect UAV
 - Generate candidate system architecture, focusing on an effective sensor suite, to detect and track small UAVs.
 - Perform quantitative system analyses to estimate detection rates and timelines.
 - Assemble a set of software tools to convert raw sensor data in to target detections.

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- Build an all-source correlator to filter out detections from known aircraft and persistent clutter sources.
- Evaluate system performance on simulated data.
- Install a prototype system on a U.S. military base for testing.
- Support transition efforts to install at overseas facilities.

	FY 2006	FY 2007	FY 2008	FY 2009
Pattern Analysis Technology	15.000	13.000	9.000	8.000

(U) The Pattern Analysis Technology thrust develops exploitation tools to form and analyze tracks of vehicle movement, and distinguish hostile behavior from benign civilian activities. It develops tools for movement pattern analysis, algorithms to predict target motions, and dynamic control methods for sensor tasking and observation scheduling. Programs in this thrust include:

- The Video Verification and Identification (VIVID) program develops technology to automate moving target strike operations for remotely piloted aircraft (RPA). Program products support both precision strike operations and military surveillance. VIVID enables the handoff of targets between wide area coverage Intelligence, Surveillance, and Reconnaissance systems and local video surveillance platforms. The technology provides techniques for precision target identification in video including fingerprinting techniques and related technology to permit reacquiring previously observed vehicles. The program also features techniques enabling video sensors to autonomously and simultaneously track multiple vehicular targets through dense traffic, temporary occlusion or exit from sensor field of view, in military surveillance and strike operations, and supports target detection of moving vehicles and/or dismounts in very low resolutions. VIVID significantly advances the capabilities of video surveillance and moving target strike for numerous military missions, including military operations in foreign urban areas. DARPA has established a MOA with the Air Force to transition the VIVID technology to the Predator. The VIVID technology is planned for transition at the conclusion of Phase II which is anticipated to be completed by the end FY 2008.
- The Dynamic Tactical Targeting (DTT) program develops sensor control and data fusion technologies to enable warfighters to manage a process to find, identify, track, target, and destroy mobile, time sensitive targets. Current targeting technology is too slow to maintain target track and support prosecution of these fleeting targets. DTT is designing and demonstrating a system that: 1) leverages existing

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National/Theater Intelligence, Surveillance, and Reconnaissance (ISR) processes for timely extraction of critical data; 2) fuses organic sensor data with ISR data from all sources to continuously estimate target location, identity, and activity; 3) dynamically tasks standoff, organic, and embedded sensors to fill ISR coverage gaps and provide relevant sensor observation in areas of tactical interest; and 4) processes and manages the voluminous data produced by various sensors in time to provide the warfighter information required to prosecute time-sensitive targets. The DTT technology is planned for transition to the Air Force in FY 2008 after a series of tests conducted with the Air Force Transformation Center.

- The Forensic Target Motion Analysis program develops and demonstrates exploitation tools to analyze Ground Moving Target Indicator Radar tracks of multiple targets to separate militarily-interesting target movement (infiltrators, envelopments, defensive site preparation, logistics support) from nominal background traffic (e.g. civilians, coalition operations). It develops libraries of movement patterns, logic to generate hypotheses about which patterns are being observed, algorithms to correlate sensor data to those patterns, and mechanisms to quantitatively score the consistency of the data with each hypothesis. It also includes tools to provide short-term (5-10 minute) predictions of target motions, thereby supporting some forms of predictive threat analysis. The tools will be integrated into Distributed Common Ground Stations in FY 2010.

(U) Program Plans:

- Video Verification and Identification (VIVID)
 - Develop techniques to automate detection, classification, and tracking of enemy, mobile, surface targets in visible and infrared motion imagery acquired by remotely piloted aircraft (RPA).
 - Develop automated techniques to detect moving vehicles and dismounts in single or multiple fixed areas for ISR operations or final inspection of weapon strike areas.
 - Demonstrate integrated, semi-automated engagement of hostile surface targets with precision weapons guided by data from video sensors on airborne platforms.
- Dynamic Tactical Targeting (DTT)
 - Demonstrate human interaction with closed-loop control of fusion and sensor management in a simulation environment.
 - Develop rapid 4D registration of multiple tracks to enable continuous tracking of numerous targets.

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- Develop information fusion methods and the capability to plan and replan appropriate sensor platforms; enable continuous track of multiple time-sensitive targets simultaneously.
- Develop end-to-end robust system capability with integrated DTT components in the Air Force Research Laboratory testbed.
- Develop system measures of performance for evaluations.
- Integrate the system with an existing Air/Ground Battlespace Simulator/Testbed and perform experiments.
- Complete a robust laboratory demonstration of the system.
- Build a system to test in field demonstrations.

- Forensic Target Motion Analysis
 - Obtain ground-truthed, wide-area Ground Moving Target Indicator (GMTI) data from operational airborne sensors.
 - Develop system architecture.
 - Create a set of motion pattern templates for both military and background activities.
 - Demonstrate capabilities to correlate real-time data to motion models.
 - Explore tools to semi-automatically delete, modify, and add models to the library.

	FY 2006	FY 2007	FY 2008	FY 2009
Network Centric Sensing and Engagement	20.683	19.662	13.000	12.361

(U) The Network Centric Sensing and Engagement thrust develops technology and tools to support precise 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. Applications include advanced target detection, acquisition, tracking, and combat identification. The technology is suited to both ground-based sensors and airborne multi-ship sensor systems. Exploiting the potential of network-centric sensing requires a number of approaches. Required technology advances include: sensor-to-sensor communications, multi-sensor management, sensor system georegistration, real-time data fusion, advanced tracking, and network-centric sensor operational modes. Programs in this thrust include:

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor Technology PE 0603767E, Project SEN-02	

- The Camouflaged Long Endurance Nano-Sensors (CLENS) program develops low-cost, lightweight micro-sensors to detect, geolocate, track, and classify targets in difficult environments. The system leverages ultra-wideband radio technologies developed for advanced communications. The combination of active, coherent, distributed-network sensing offers unique capabilities not possible from stand-alone, single-point systems. CLENS enables reduced force protection and supports monitoring of borders and critical CONUS sites, and long-duration covert monitoring of target sites such as terrorist camps. CLENS has broad application in support of comprehensive intelligence, surveillance, and reconnaissance for situational awareness and enables persistent sensing of dismounted combatants in forested areas and other tough environments. The CLENS technology is planned for transition to the SOCOM at the conclusion of Phase III anticipated to be completed by FY 2007.
- The Quint Networking Technology (QNT) is a modular, multi-band, network data link program focused on providing capabilities that close the seams between five nodes - aircraft, unmanned combat air vehicles (UCAV), weapons, tactical unmanned air vehicles (UAV's) and air control ground units. The program designs, develops, evaluates and demonstrates robust, affordable data link technologies suitable for use by weapons, tactical UAV's, and air control units. This includes shrinking the package size of data link capabilities from the current 1000 in³ to 10 in³, the size of a cell phone. These data links enable precision strike and efficient machine-to-machine targeting against time critical and mobile targets, support combat identification of targets, disseminate tactical UAV and ground sensor data, and provide bomb impact assessment (BIA). The data links allow secure weapon handoff from the launch platform to any of several control platforms in the combat area, both air and surface. The QNT units provide two modes: a low rate bi-directional mode and a high data rate mode capable of either continuous or a burst imagery/video transmission. Dynamic net resource management technology will scale to support hundreds of vehicles in flight. Advanced information security techniques provide secure weapon data links and controller handovers. QNT technology transitions via insertion into DoD's existing and emerging weapons, tactical UAV's, and tactical handheld units after the program is completed in FY 2008.
- The Target Geolocation from a UAV (GeoLoc) program uses novel photogrammetric techniques to provide accurate geolocation of ground targets (<10 meters CEP) from small and mid-size UAVs. This represents an order of magnitude improvement in accuracy compared to instrumentation used on high-end UAVs. Further it requires no new hardware on-board the aircraft and does not rely upon prepared reference imagery. This photogrammetric technology will permit UAVs to not only observe targets for the first time, but also to direct fire from coordinate-seeking weapons. Furthermore, the technology will be extended to provide real-time geolocation on moving vehicles as well, enabling engagement of moving targets without use of laser designators, and without any human operators in harms way.

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The thrusts and future capabilities of the GeoLoc Program are: detection, precision identification, tracking, and destruction of elusive surface targets from networked manned and unmanned systems. Technologies are planned for transition to the Air Force.

- The Wide Area Video Exploitation program will develop technology to enable wide field-of-view visible and infrared imagery (EO/IR) framing cameras in airborne platforms to detect and track, in real time, multiple moving objects under a wide range of conditions and topography. Current systems are able to collect data and provide an ability to backtrack individual targets post-facto. The Sonoma-Plus program aims to provide a real-time ability to track in forward time multiple potential targets from high-altitude video imagery. On-board processing will be crucial since imagery data volumes will amount to gigabytes per second. Multi-hypothesis tracking of dozens and eventually hundreds of entities will also be developed, and imagery stabilization based on prior digital elevation models will also facilitate tracking and track analysis. Technologies are planned for transition to the Army.

(U) Program Plans:

- Camouflaged Long Endurance Nano-Sensors (CLENS)
 - Developed tracking algorithms to consolidate range-only detects into contact tracks.
 - Fabricated targeted form factor micro-sensors.
 - Conducted ground demo with one receiver/processor and many micro-sensors.
- Quint Networking Technology (QNT) (formerly Rotorcraft SIGINT/COMINT Geolocation)
 - Conduct analysis, design and hardware-in-the-loop tests.
 - Build and evaluate brassboard in stage 1 tests.
 - Cycle and test brassboard Stage 2 tests and flight tests.
- Target Geolocation from a UAV (GeoLoc)
 - Evaluate platform noise models.
 - Demonstrate reliable point feature extraction.
 - Integrate with UAV telemetry.
 - Demonstrate real-time geolocation from airborne video.
 - Integrate and transition to Common Ground Station.

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- Extend algorithms for geolocation of moving targets.
- Demonstrate real-time geolocation of moving targets.
- Wide Area Video Exploitation
 - Evaluate imagery and algorithms to perform stabilization and multi-hypothesis tracking.
 - Build video processing architecture to demonstrate an ability to track 50 or more moving entities in playback mode of 50 Megapixel video data with a frame rate of at least 1 Hz.
 - Integrate computer architecture with a collection platform to provide tracking over hundreds of entities simultaneously in 100 Megapixel (or higher) video data.

	FY 2006	FY 2007	FY 2008	FY 2009
Persistent Exploitation	19.591	20.262	20.632	23.178

(U) The new Persistent Exploitation program integrates a wide variety of sensors, data links, exploitation tools, correlators, and pattern analyzers into an end-to-end capability, focusing on counter-insurgency missions. These missions must be supported at all hours of the day, over large areas, and against a diverse set of targets, characteristics that no homogeneous sensor architecture can address. It ties separate hardware and software components together so that interactions among them can be defined, assessed, evaluated, and refined. It emphasizes real-time testing in realistic environments (e.g., the National Training Centers) so that subtle dependencies and interactions can be discovered.

(U) The Persistent Operational Surface Surveillance and Engagement (POSSE) program creates a system of systems framework in which a mix of surveillance assets, both operational and developmental can be coordinated and exploited to yield persistent surveillance of insurgent activities. The program focus is on the Iraqi theatre, using a spiral approach designed to insert enhanced counter-insurgency capabilities into operational use as soon as possible, followed by improvements and enhancements as they become integrated through a domestic testbed. The efficacy and timeliness of surveillance afforded by the program's systems-level approach will significantly exceed that afforded by individual ISR components, and will result in substantially enhanced force protection for fixed sites, convoys, and military operations. The framework includes data exploitation at both forward-deployed and national sites to support both quick-reaction cuing to engage insurgents, and deeper forensic

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analysis to identify their support structures. The POSSE program is jointly funded with the Joint Improvised Explosive Device Defeat Task Force. POSSE technologies are planned for transition to the U.S. Army Intelligence and Security Command.

- (U) Program Plans:
- Conduct a comprehensive analysis of existing surveillance assets in the Iraqi theatre.
 - Develop a systems architecture and asset utilization plan that maximizes persistent surveillance capability in high priority regions, based on currently available assets.
 - Identify coverage and gaps and required new capability needed to satisfy persistent surveillance and force protection objectives.
 - Define a spiral development plan that emplaces initial capability in theatre as early as possible, and identifies needed enhancements and new capabilities to be inserted in subsequent phases.
 - Initiate accelerated development of gap-filler sensors and/or platforms.
 - Develop an integrated capability to exploit all theatre-deployed ISR assets in a coordinated, systematic manner.
 - Test an initial POSSE exploitation system at the National Training Center.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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