RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2008
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE: Sensor Technology; PE 0603767E

COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	189.795	195.213	226.470	224.477	233.798	247.071	249.050
Surveillance and Countermeasures Technology SEN-01	45.562	63.497	80.723	80.774	83.760	97.034	99.014
Sensors & Exploitation Systems SEN-02	144.233	131.716	145.747	143.703	150.038	150.037	150.036

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

	FY 2007	FY 2008	FY 2009
Previous President's Budget	188.781	196.462	219.407
Current Budget	189.795	195.213	226.470
Total Adjustments	1.014	-1.249	7.063
Congressional program reductions	0.000	-1.249	
Congressional increases	0.000		
Reprogrammings	6.000		
SBIR/STTR transfer	-4.986		

(U) Change Summary Explanation:

FY 2007	Increase reflects an anticipated reprogramming and the SBIR/STTR transfer.
FY 2008	Decrease reflects reductions for Section 8097 Contractor Efficiencies and Section 8104 Economic Assumptions.
FY 2009	Increase reflects expansion of SALTI program in Project SEN-02 and enhanced technologies to detect and defeat underground facilities in Project SEN-01.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Surveillance and Countermeasures Technology SEN-01	45.562	63.497	80.723	80.774	83.760	97.034	99.014

(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. The collection of programs formerly referred to as Counter Underground Facilities has been expanded into separate programs (the Low-Altitude Airborne Sensor System (LAASS) program, the Cross-Border Tunnels (CBT) program, the Robust Tunnel Mapping and Operations program, and the Airborne Tomography using Active Electromagnetics (ATAEM) program) to provide additional insight.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Low-Altitude Airborne Sensor System (LAASS)*	10.472	19.464	15.750

*Previously part of Counter Underground Facilities (UGF).

(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). By passively capturing emissions associated with underground facility presence and operations, and doing so using airborne sensors (acoustic, electromagnetic, gravity), LAASS can significantly increase our ability to seek out

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underground facilities and map out their vulnerabilities and backbone structure. LAASS technologies are planned to transition to NORTHCOM, SOUTHCOM, STRATCOM, or Defense Threat Reduction Agency (DTRA) at the end of FY 2009.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed algorithm concepts and generated performance predictions for LAASS against Targets of Interest (TOI).
- Designed and developed prototype LAASS passive electromagnetic and acoustic sensor payload and tested sensor performance characteristics on an unmanned air vehicle (UAV).
- Identified and tested methods to isolate magnetometer sensor from platform vibration and electromagnetic interference.

FY 2008 Plans:

- Generate system design for passive demonstration and evaluation prototype system.
- Integrate and test passive sensor hardware (platform-isolated electromagnetic (EM), acoustic) onto user-specified unmanned air system (UAS).
- Develop system requirements for LAASS gravity gradiometer payloads (sensor characteristics, platform envelope) against TOI.

FY 2009 Plans:

- Develop and integrate passive system software (detection, characterization) and demonstrate system performance against a relevant facility.
- Produce system design and initiate development of gravity gradiometer prototype evaluation system.

	FY 2007	FY 2008	FY 2009
Cross-Border Tunnel (CBT)*	0.676	1.852	3.750

*Previously under Counter Underground Facilities (UGF).

(U) The Cross-Border Tunnel (CBT) program is developing technologies and systems to detect small tunnels used to breach security perimeters and national borders. The program goal is 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, and

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exposure of friendly forces. The CBT program is currently performing collections of seismic and electromagnetic (EM) data at a test bed using current state of the art sensors from the geophysical industry.

(U) Starting in FY 2008, the program will focus on a Fast-Scan CBT Detection technique, which will investigate, develop, and transition 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 is to provide rapid detection of anomalous subsurface structures consistent with voids. The technical challenges include: 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 program will transition to the Services in FY 2010.

(U) Program Plans:

FY 2007 Accomplishments:

- Built test bed for evaluation of CBT and other Counter Underground Facilities (CUGF) technologies.
- Tested innovative imaging techniques using seismic and electromagnetic illumination of Target of Interest (TOI.)
- Assessed methods for robust employment subject to operational limitations.

FY 2008 Plans:

- Investigate alternative technologies contributing to the Fast Scan CBT Detection technique.

FY 2009 Plans:

- Develop and validate a detection concept suited for use in protection of controlled areas and borders.
- Determine the design requirements for the source characteristics and sensor/source geometry that optimizes the detection performance.
- Commence the development of the Fast Scan CBT Detection technique for an off board platform integration.

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	FY 2007	FY 2008	FY 2009
Robust Tunnel Mapping and Operations	0.000	0.000	3.970

*Previously under Counter Underground Facilities (UGF).

(U) The Robust Tunnel Mapping and Operations program will investigate, develop, and transition a single system that jointly maps underground tunnel networks and supports below-ground communications and navigation, to meet the operational needs of ground forces conducting urban or counter-UGF operations. The program will explore and identify active sensing strategies that in the process of mapping the extent of the tunnel network can simultaneously support internal operations. The technical challenges include 1) identification of a single phenomenology to meet mapping and operational needs, 2) development of man-portable sensors for communications and navigation, and 3) technology integration to a single system. This program will transition to Special Operations Forces in FY 2011.

(U) Program Plans:

FY 2009 Plans:

- Develop and verify concept feasibility to meet the needs of ground forces conducting urban or counter-UGF operations.
- Quantify achievable system performance in an environment of underground tunnel networks.
- Establish design requirements for source characteristics (location, spectrum, duration) and sensor/radios.

	FY 2007	FY 2008	FY 2009
Airborne Tomography using Active Electromagnetics (ATAEM)	4.196	5.409	9.136

(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 (UGF) or perimeter-breaching tunnels. The ATAEM system illuminates the ground with 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, and demonstrate them on an appropriate airborne platform. The ATAEM program will first validate the system concept for EM sources, sensor payloads, and associated signal processing through modeling and data collection against

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relevant underground structures. An integrated system combining active illumination, sensing, and detection processing will then be developed and demonstrated on an appropriate unattended air system (UAS). This capability is expected to transition to the Army, USMC, and U.S. Special Operations Command in FY 2011.

(U) Program Plans:

FY 2007 Accomplishments:

– Developed sensor suite comprised of vibration-isolated electric and magnetic field sensors.

FY 2008 Plans:

– Build sensor suite comprised of vibration-isolated electric and magnetic field sensors.
– Investigate and develop electromagnetic illumination sources.
– Integrate sensor suite into helicopter tow body.

FY 2009 Plans:

– Collect and analyze operationally relevant data over multiple Targets of Interest (TOI) using helicopter tow body.
– Document performance as a function of operational parameters (illumination sources, flight parameters).
– Develop system design for final demonstration system.

	FY 2007	FY 2008	FY 2009
Strategically Hardened Facility Defeat	4.000	12.000	15.500

(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

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leverage recent advances in earth-penetrating technologies for full defeat of strategically hardened facilities. This program will transition to the Defense Threat Reduction Agency (DTRA) in FY 2011.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed new penetration technologies capable of meeting deployable weight and size goals.
- Demonstrated advanced penetration and energy supply technologies through field trials.
- Developed the ability to sense and navigate to the targeted functional area.
- Demonstrated sensing and navigation capabilities through field data collections and high fidelity modeling.
- Conducted small-scale tests of deployment capabilities.

FY 2008 Plans:

- Develop robust, self-contained aerial deployment options that can interface with existing air platforms.
- Integrate advanced penetration and energy supply technologies.
- Demonstrate penetration, energy, sensing, and navigation capabilities through field trials.
- Demonstrate deployment capabilities.

FY 2009 Plans:

- Develop packaging and integration technologies that can withstand harsh environments.
- Design and initiate development of deployable system with advanced penetration and navigation capabilities.
- Integrate component subsystems into deployable platform.

	FY 2007	FY 2008	FY 2009
Visibuilding	11.218	9.000	10.000

(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 allow mapping of building pathways and stairways by monitoring traffic through buildings. Multipath

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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

FY 2007 Accomplishments:

-- Evaluated candidate designs for wall-penetrating technologies for building layout and combatant localization.
-- Performed electromagnetic simulations showing detailed building penetration physics.
-- Developed algorithms for determining building layouts from electromagnetic radar returns.

FY 2008 Plans:

-- Develop instrumentation radar systems for detailed building radar measurements.
-- Perform experiments on building imaging and insurgent localization within structures.

FY 2009 Plans:

-- Demonstrate multipath exploitation approaches for interior building imagery through three exterior-grade walls.
-- Design, build, and test prototypes for use in full-scale demonstration.

– Radar Scope

FY 2007 Accomplishments:

-- Evaluated candidate designs for through wall motion detection.
-- Carried out feasibility measurements and modeling.

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-- Designed, built and tested prototypes for use in full-scale demonstration.
-- Transitioned for use in full-scale demonstration.

FY 2008 Plans:

-- Develop extensions of this technology for new application areas, including standoff triage tools for use by medics.

	FY 2007	FY 2008	FY 2009
Surveillance and Threat Neutralization in Urban Environments	7.000	5.772	0.000

(U) This program is investigating technologies 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 studied included detection of anomalies in vehicle dynamics; stand-off identification and localization of explosive vapors/effluents; high fidelity 3-Dimensional (3-D) mapping performed from a high altitude (>15,000 feet) airborne platform for Improvised Explosive Device (IED) detection, high fidelity 3-D surveillance performed from autogyro mortar rounds utilizing stereo vision, and precision emplacement of sensors in an urban environment. 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:

FY 2007 Accomplishments:

– Completed study on Detection of Anomalies in Vehicle Dynamics (DAViD) and documented results.
– Completed successful airborne demonstration of data-driven high resolution 3-D Laser Identification Detection and Ranging (LIDAR).
– Completed initial sensor development to enable non line of sight (NLOS) sensors.

FY 2008 Plans:

– Evaluate candidate technologies for wide-area/stand-off and choke-point/portal-screening applications.
– Prove feasibility in lab on sub-scale tests.

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

(U) The Hostile Fire Indicator (HFI) program explored 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 near the crew cabin or some other critical and monitored system. The HFI system was 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:

FY 2007 Accomplishments:

– Measured acoustic/vibrational frequency background noise on one U.S. Army and two Special Operation Forces helicopters.

	FY 2007	FY 2008	FY 2009
Speckle Exploitation for Enhanced Reconnaissance (SEER)	4.000	7.000	6.000

(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:

FY 2007 Accomplishments:

– Conducted system concept developments and laboratory proof-of-concept demonstrations.

FY 2008 Plans:

– Develop algorithms that reliably and uniquely associate target signatures with speckle patterns.
– Implement algorithms using optical Micro Electro-Mechanical systems (MEMs) or other related technologies to achieve reduced size, weight and power.
– Demonstrate functional performance of single focal plane array to create active speckle images of calibration and field targets.

FY 2009 Plans:

– Perform major system design trades.
– Demonstrate multiple focal plane array foliage penetration performance (spatial resolution and composite image formation time).
– Conduct field experiments to measure brassboard performance in turbulent environments.

	FY 2007	FY 2008	FY 2009
Rescue Transponder (RT)	2.000	3.000	2.000

(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 Army and USMC in 2009.

(U) Program Plans:

FY 2007 Accomplishments:

– Developed tags that enabled the user to be identified and localized by airborne or advantaged receivers.
– Designed a custom digital and microwave-integrated circuit to allow tag miniaturization.

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– Built, tested, and demonstrated the prototype tags and transmitters capabilities at military facilities.
– Conducted airborne demonstration and completed interference and low probability of detection (LPD) assessment to demonstrate military utility to transition partner USMC at Camp Pendleton, CA and Quantico, VA.

FY 2008 Plans:
– Initiate limited prototype production to support USMC operational field assessment.
– Complete equipment development and enhancements to support system performance capabilities for military use.

FY 2009 Plans:
– Complete transition between DARPA and USMC.

	FY 2007	FY 2008	FY 2009
AudiVis	0.000	0.000	3.500

(U) The AudiVis program seeks to extract high-rate (kHz+) temporal data from a foveated vision infrared (IR) sensor. This provides the capability to optimize data processing at the pixel level, including data fusion in real time at the pixel level. The concept goes well beyond foveated vision and bandwidth sensor compression concepts by enabling a low light sensor to not only act as an intelligent cueing device but also to shift to a high frame rate mode. This will provide visible IR with applications into complimentary metal-oxide-semiconductor visible sensors as well as temporal (frequency) data on objects of interest within the field of view of the IR sensor. This will enable the detection of acoustic and high modulation rate signatures from low-light IR sensor and provide on-sensor data fusion capabilities for rapid detection and identification. The use of a networked array of these high frequency capable low light sensors in an urban environment will provide autonomous situational awareness. This program will transition to the Army for urban operations applications in FY 2012.

(U) Program Plans:

FY 2009 Plans:
– Define system performance requirements.
– Develop system architecture design.

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	FY 2007	FY 2008	FY 2009
Combat Laser Infrared Countermeasure (IRCM) Proactive Survivability System	0.000	0.000	3.000

(U) The Combat Laser Infrared Countermeasure (IRCM) Proactive Survivability System (CLIPSS) will enable air dominance at low altitude and at night against current and near term near infrared (NIR) and mid-wave infrared (MWIR) based threats including man portable air defense (MANPAD), based on proactive infrared countermeasures (PIRCM). Leveraging the ongoing 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 and MWIR bands and the reactive capability of the Affordable Laser IRCM Survivability System (ALISS), 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. CLIPSS will provide U.S. aircraft the same ability to geo-locate, evade, jam, or destroy optically based air defenses and will evolve U.S. capabilities from reactive end game countermeasures to proactive capabilities that increase threat-warning times, deny launch and put electro-optical/IR air defense threats at risk. This program will demonstrate an initial integrated proactive and reactive IRCM pod based flight system that will address shorter range, high duty cycle threats for vulnerable low altitude platforms in the NMIR wavebands. The primary technical obstacles 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. CLIPSS technology is planned for transition to the Services in FY 2012.

(U) Program Plans:

FY 2009 Plans:

- Develop preliminary design for integrated proactive IRCM pod incorporating current reactive IRCM capabilities and components.
- Demonstrate integrated subsystem performance for transmitters and receivers.
- Develop final design incorporating advanced high gain 128x128 FPAs.

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	FY 2007	FY 2008	FY 2009
Handheld Through-Wall Synthetic Aperture Radar (SAR)	0.000	0.000	2.500

(U) Urban operations have become an essential part of military and peace-keeping operations. Currently, buildings provide a safe refuge from our reconnaissance and surveillance capabilities. Technology developed in the Radar Scope program provides a personnel detection device which can detect movement of people through non-metallic walls like concrete, adobe, cinderblock, or drywall. Some commercial techniques attempt to provide crude imaging of a room's contents, but are limited by the size and aperture of the device. This program will provide an synthetic aperture imaging capability into a room by sweeping a small handheld system over the face of a wall, an arbitrarily large aperture can be recreated to improve the imaging capability to the physical propagation and dispersion limits of the wall. This program will transition to the Army in FY 2011.

(U) Program Plans:
FY 2009 Plans:
- Perform through-wall measurements to measure propagation and dispersion effects.
- Develop motion measurement capabilities for monitoring the position of the radar for synthetic aperture measurement.
- Develop imaging algorithms that compensate for wall penetration effects.

	FY 2007	FY 2008	FY 2009
Standoff Triage	0.000	0.000	3.000

(U) Medics who risk their lives under fire to assess individuals who may already be dead incur many casualties. Current technologies have demonstrated breathing or heart rate detection using radar systems, as well as other life signs such as pulse using laser vibrometry or infrared and even chemical detection of respiration products. These measurements have usually been under well-controlled environments. The Standoff Triage program will extend these approaches to allow remote monitoring of life in battlefield environments to determine the state of individuals before sending in emergency medical personnel under fire. This effort will examine optical, infrared, and RF techniques to monitor key life signs such as respiration and heart rate to determine the timing and magnitude of a potential medical response. The Standoff Triage program will develop methods to measure health status of people at distances of 10 to 100 meters, and will be evaluated for both handheld operations by medics

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on the ground and airborne platforms that can survey a battlefield after a conflict. In addition to casualty assessment, these technologies may be useful in disaster relief or detecting the presence of potential adversaries. This program will transition to the Army and USMC in 2012.

(U) Program Plans:
FY 2009 Plans:
- Evaluate candidate designs for remotely monitoring human life signs in battlefield scenarios.
- Carry out feasibility measurements and modeling.
- Design, build, and test prototypes for use in full-scale demonstration.

	FY 2007	FY 2008	FY 2009
Dielectric Detection of Explosives	0.000	0.000	2.617

(U) The Dielectric Detection of Explosives program will develop a system for the detection of bombs that have become deadly and destructive weapons in current urban operations. The approach will measure dielectric properties of materials to discriminate classes of materials. Low frequency dielectric spectral signatures can be obtained through clothes, walls, and other non-metallic surfaces. Based upon the size of the sensor system, these signatures can potentially be pushed out to several meters. This can enable portal defense application, vehicle inspection, and even monitoring of explosive materials through walls. The Dielectric Detection of Explosives approach can be integrated with signatures from other sensors to provide a more comprehensive multi-spectral discrimination solution. Transition is planned to the Army and Marine Corps in FY 2012.

(U) Program Plans:
FY 2009 Plans:
- Develop collection sub system for demonstrating feasibility of material discrimination and object classification.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Sensors & Exploitation Systems SEN-02	144.233	131.716	145.747	143.703	150.038	150.037	150.036

(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) Persistent Exploitation, to combine sensors and exploitation tools in an integrated system to address counter-insurgency missions; 2) Network Centric Sensing and Engagement, to explore novel processing architectures enabled by the proliferation of data links; 3) Pattern Analysis Technology, to distinguish suspicious movement and activity from benign clutter; 4) Target Identification Technology, to build tools to automatically identify targets; 5) Advanced Radar Sensing Technology, to observe targets at night and in bad weather; 6) Advanced Airborne Optical Sensing, to provide high-resolution images over large areas; 7) Synthetic Aperture Ladar for Tactical Imaging (SALTI), to produce high-resolution 3-D imagery at long ranges; 8) Ground Targeting Sensors, to increase our ability to detect close-in ground targets; and 9) Soldier-borne Sensor Technology, to improve individual soldiers' situational awareness and effectiveness.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Persistent Exploitation	20.262	20.632	23.178

(U) The 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

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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 Intelligence, Surveillance, Reconnaissance (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 cueing to engage insurgents, and deeper forensic analysis to identify their support structures. POSSE attacks the insurgent network to find activities indicative of bomb making perpetrators. 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:

FY 2007 Accomplishments:

- Conducted a comprehensive analysis of existing surveillance assets in the Iraqi theatre.
- Developed a systems architecture and asset utilization plan that maximizes persistent surveillance capability in high priority regions, based on currently available assets.
- Identified coverage and gaps and required new capability needed to satisfy persistent surveillance and force protection objectives.
- Defined 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.
- Exercised these systems in near-real time through a series of live exercises at the National Training Center (NTC), in a realistic operational environment, in direct support of units conducting Mission Readiness Exercises prior to deployment to Iraq.

FY 2008 Plans:

- Continue semi-annual exercises at the NTC, demonstrating continued maturation of the near-real-time exploitation capabilities.
- Integrate capabilities into existent operational ISR exploitation cells, evaluating them in NTC exercises and followed with transition to deployed analysis cells.

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- Expand investigation of close proximity sensor experiments designed to differentiate a bomb maker's location from adjacent structures.
- Integrate proximity sensor capabilities into the near-real-time POSSE exploitation process.
- Evolve the temporary test facilities at the NTC into a more permanent test facility, Joint IED Attack the Network Testbed (JIANT).
- Expand JIANT to be accessible to other DoD programs and provide connectivity to operational and R&D facilities.

FY 2009 Plans:

- Continue spiral development with semi-annual exercises at the NTC and spin off mature capabilities to deployed analysis cells.
- Exercise JIANT in coordination with remote operational and R&D facilities to test and demonstrate operational capabilities.
- Evolve JIANT accessibility and utility to programs beyond POSSE as a DoD test bed.
- Test operational capabilities at the NTC with operational analysis cells and deploy demonstrated capabilities to theater.

	FY 2007	FY 2008	FY 2009
Network Centric Sensing and Engagement	13.900	11.419	5.585

(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:

- The Quint Networking Technology (QNT) is a modular, multi-band, network data link program focused on providing capabilities that close the seams between four nodes - manned aircraft, 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 in^3 to 10 in^3, the size of a cell phone. These data links enable precision strike and efficient machine-to-machine targeting against time critical and mobile

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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 2009.

- The Wide Area Video Exploitation program will develop technology to enable wide field-of-view Electro-Optical/Infrared (EO/IR) imagery 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.

- The Expeditionary Distributed Common Group System (DCGS) Global Information Grid (GIG) for Exploitation Services (EDGES) program provides layered and persistent Intelligence, Surveillance and Reconnaissance (ISR) of asymmetric and irregular warfighters in support of Marine Corps and Special Operations. The unique feature of EDGES will be the ability to intelligently interpret soldier requests for situation assessment data, access local tactical threat data bases, and fuse multi-sensor data for accurate, timely target detection, tracking, and identification. This system approach couples the deployment of a dedicated UAV system responsive to these small units, with data preprocessing and feature extraction to enable the efficient and timely transmission of actionable combat information to the troops. With the ability to support two-way communications with wideband reach back, information and observations received from the small operation unit will be integrated into the EDGES information data base and communicated to the higher commands. Through the ISR processing algorithms, sensor fusion operations and communication connectivity to the area of regard as well as the higher level of commands, EDGES will function as an ISR tool to the small unit and provide actionable persistent and dedicated service. This program is planned to transition to the Marine Corps.

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(U) Program Plans:

– Quint Networking Technology (QNT)
FY 2007 Accomplishments:
-- Designed QNT radios, waveforms and network.
-- Conducted analysis, design and hardware-in-the-loop tests.
FY 2008 Plans:
-- Build and evaluate brassboard in Stage 1 tests.
FY 2009 Plans:
-- Cycle and test brassboard Stage 2 tests and flight tests.

– Wide Area Video Exploitation
FY 2007 Accomplishments:
-- Developed signal processing architecture.
-- Validated architecture on non-real-time data set.
FY 2008 Plans:
-- Prototype video processing architecture.

– Expeditionary DCGS GIG for Exploitation Services (EDGES)
FY 2009 Plans:
-- Develop and refine multi-sensor data fusion techniques to provide detection and classification of tactical threats.
-- Demonstrate high confidence identification of irregular warfighters through simulation, emulation, and field tests.
-- Develop a UAV “system” controlled by and responsive to the small unit with autonomous deployment and data collection capability.

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	FY 2007	FY 2008	FY 2009
Pattern Analysis Technology	13.000	6.000	1.000

(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 reacquire 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 of 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 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.

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- 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 2009.

(U) Program Plans:

– Video Verification and Identification (VIVID)
FY 2007 Accomplishments:
-- Integrated real-time VIVID software with MTS Sensor.
FY 2008 Plans:
-- Demonstrate real-time software components on tower.

– Dynamic Tactical Targeting (DTT)
FY 2007 Accomplishments:
-- Demonstrated human interaction with closed-loop control of fusion and sensor management in a simulation environment.
-- Developed rapid 4-D registration of multiple tracks to enable continuous tracking of numerous targets.
-- Developed information fusion methods and the capability to plan and replan appropriate sensor platforms; enable continuous track of multiple time-sensitive targets simultaneously.
-- Developed end-to-end robust system capability with integrated DTT components in the Air Force Research Laboratory testbed.
-- Developed system measures of performance for evaluations.
FY 2008 Plans:
-- Integrate the system with an existing Air/Ground Battlespace Simulator/Testbed and perform experiments.
-- Complete a robust laboratory demonstration of the system.
-- Build system to test in field demonstrations.

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– Forensic Target Motion Analysis
FY 2008 Plans:
-- Obtain ground-truthed, wide-area Ground Moving Target Indicator (GMTI) data from operational airborne sensors.
FY 2009 Plans:
-- Integrate into Distributed Common Ground Stations.

	FY 2007	FY 2008	FY 2009
Target Identification Technology	17.344	16.979	13.000

(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. Four programs are funded in this thrust:

- The Tactical Sensor Network Technologies (TSNT) program developed detection, tracking, identification, and pattern analysis capabilities that operate in all nodes (fixed or mobile) within a networked, distributed multi-sensor system. The processing is performed at each network node depending on the sensors reporting to that node, the subscribing commanders, and resource management decisions. TSNT leveraged the advantages of a self-forming adaptive network for signal processing and its algorithms adapt based on self-discovered network topology, power management constraints, communications bandwidth limitations, and constraints found in the local environment. TSNT has demonstrated resilience to the failure of any node while maintaining sufficient consistency to support commanders' collaborative tactical planning. Technologies transitioned to the U.S. Army (PEO Intelligence and Electronic Warfare Directorate).

- 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 3-D Reasoning (3DR) initiative is a follow-on program to E3D which will develop techniques to automatically generate large, fully annotated 3-D urban models from the rich sources of high-resolution laser radar data available from ground-based and airborne platforms. 3DR

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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 3-D and 2-D data from disparate ground and airborne sources; (2) new 3-D recognition approaches that identify objects within a class based on limited initial training; (3) a flexible and expandable 3-D 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 2008.

- 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 key target features and other discriminates. The program will engage universities and industry to develop technology for integrated near real time automation support for real time airborne target acquisition and target confirmation using a combination of advanced radar exploitation and electro-optical/infrared imagery. This initiative will also develop and demonstrate 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. It 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 and subsequently to the U.S. Army Future Combat System. Most developmental work will be performed by universities and industrial contractors, with system architecture, performance trades, and evaluation performed by Government participants and transition partners.

- 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.

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(U) Program Plans:

– Tactical Sensor Network Technologies (TSNT)
FY 2007 Accomplishments:
-- Developed algorithms for distributed situation assessment at all nodes of a networked group of sensors.
-- Integrated and assessed distributed system performance in large-scale simulation and limited-scale testing.
-- Demonstrated robustness of TSNT networked sensing under network and environmental stresses.
-- Incorporated tracking, target identification, and target assignment algorithms for fully distributed operation.

– Exploitation of 3-D Data (E3D)
FY 2007 Accomplishments:
-- Demonstrated that the 3-D shape and structure of vehicles permits confident identification.
-- Conducted real data collection using laser radar, recognition by parts: 98% accuracy in <5 min.
-- Successfully demonstrated vehicle fingerprinting using shape and color.
FY 2008 Plans:
-- Conduct real time data collection with PFP of 90.3% in <10 secs for models in library.

– All-Source Target Characterization
FY 2007 Accomplishments:
-- Collected full spectrum data.
-- Analyzed reliability and sensitivity of each source.
FY 2008 Plans:
-- Develop tools to permit rapid user interaction with imagery and processing results.
FY 2009 Plans:
-- Evaluate performance in field exercises and demonstrations.

– Detect UAV
FY 2008 Plans:
-- Generate candidate system architecture, focusing on an effective sensor suite, to detect and track small UAVs.
-- Collect small UAV signatures.

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FY 2009 Plans:
-- Develop target tracker.
-- Validate classifier performance.
-- Exercise full processing chain.
-- Integrate kill mechanism.

	FY 2007	FY 2008	FY 2009
Advanced Radar Sensor Technology	12.000	14.000	18.000

(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 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 designed a rapidly-deployable airborne system to provide assured protection of permanent or temporary U.S. base camps in hostile territory. AAS could accommodate 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 could then 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.

- The Sensing and Exploitation of Urban Movers (SE-UM) 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 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

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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.

- 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. Technology is planned for transition to the Air Force.

- The Boreal program will develop and demonstrate a rapidly deployed, wide-area surveillance system for detection, tracking, precision location and engagement of high value targets under dense foliage. The Boreal system would be installed on a high flying fixed wing aircraft, and would rapidly search large areas for fixed and moving targets under foliage and provide simultaneous Ground Moving Target Indicator (GMTI) and Synthetic Aperture Radar (SAR). The GMTI will detect and locate dismounts and vehicles moving under foliage and the SAR will for reveal buildings, vehicles and lines of communications under foliage. The goals of this program include demonstrating real-time onboard wide-area GMTI and simultaneous SAR and achieving precise geolocation (7-10m) of moving dismounts. This technology will transition to the Air Force.

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- The Next Generation RF Antenna System program will develop and demonstrate an ultra-sensitive Radio-Frequency (RF) receiver made from lightweight non-reciprocal materials for precise direction and frequency sensing, tunable over a broad frequency range. This system will enable signals intelligence (SIGINT) at extended ranges by detecting faint or distant signals with accurate incident angle and frequency determination. The resulting system will provide greater than 10 dB improvement over existing amplifiers and antenna systems. This program is planned for transition to the Air Force by 2010.

(U) Program Plans:

– Augmented Aerial Sentry
FY 2007 Accomplishments:
-- Completed system architecture study.

– Sensing and Exploitation of Urban Movers (SE-UM)
FY 2007 Accomplishments:
-- Completed data collection, simulated data, dismounted characterization analysis.
FY 2008 Plans:
-- Conduct real-time demonstration.
FY 2009 Plans:
-- Transition to Air Force and Navy.

– NetTrack
FY 2007 Accomplishments:
-- Developed algorithms for radar feature association, radar tracking, long-term hypothesis management and sensor resource management.
-- Developed simulated test bed of vehicle movement in semi-urban areas to demonstrate the ability of radars to track ground moving vehicles.
-- Commenced integration of multiple components into tracker test bed.
FY 2008 Plans:
-- Improve capabilities for using vehicle radar signatures to associate vehicle observations.
-- Demonstrate NetTrack operations in simulation.

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FY 2009 Plans:
-- 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.

– Dual Beam Lynx
FY 2008 Plans:
-- Conduct Preliminary Design Review.
-- Develop algorithms.
FY 2009 Plans:
-- Develop space time adaptive processing.
-- Perform flight test and data collection.

– Boreal
FY 2009 Plans:
-- Develop and test advanced signal processing algorithms.
-- Develop and test endbody design.
-- Collect data with non-real time non form-factor testbed and use this data to validate performance predictions.

– Next Generation RF Antenna System
FY 2009 Plans:
-- Model and simulate of materials to assess and optimize non-reciprocal behavior.
-- Fabricate and test 1-D material sample.
-- Extend non-reciprocal materials to detect radiation at oblique angles and to determine incident radiation.

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	FY 2007	FY 2008	FY 2009
Advanced Airborne Optical Sensing	22.950	22.100	29.385

(U) The Advanced Airborne Optical Sensing thrust develops large aperture sensors and image processing systems to provide video coverage of large areas and detection and identification of elusive targets at long range and under foliage and camouflage. It builds optics, gigapixel focal plane arrays, advanced laser radar technologies, 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 or obscuration due to foliage and camouflage. Programs in this thrust include:

- 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 (>10km) 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-3D precision ID capabilities and track fusion techniques. The objectives are to provide: (1) high range resolution 3D imaging; (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 coordinate guided weaponry. The SPI-3D system employs optics and focal plane arrays and gimbals combined with a novel Pockels cell range measurement technique. The system will operate in the near infrared spectral region to minimize observability. SPI-3D technologies are being designed to achieve a Class IV UAV-compatible (Predator, Firescout & Warrior) configuration for installation into a Multi-spectral Targeting System (MTS) turret for transition to the Air Force at the conclusion of Phase III, which is anticipated to be completed by FY 2010. The program will also aid in Geiger Mode Avalanche Photodiode (GmAPD) technology transfer for the production of high speed, ultra sensitive photodetectors to systems requiring operation at very low photon counts. This will support long range sensors that can detect highly obscured targets (≥ 95%) under canopy/camouflage.

- 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

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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 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 of the program anticipated in FY 2009.

- 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 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. The effort will improve performance of the technology, specifically using diffuse reflective targets, targets with lower contrast and reduced intensity reference beam. Additionally, suitable missions and platforms for the technology will be identified. SPIDAR technologies will be transitioned to the Air Force in FY 2013.

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- The Hyperspectral Framing program will develop and demonstrate a system for collecting and processing hyperspectral (HSI) data operating as a framing sensor, instead of as a line scanner with the constraints of current sensors. The system will accept wide spectral content over hundreds of bands permitting extremely powerful air and space-borne reconnaissance for real time target detection. The resulting sensor and processing system will provide a 2-3 order of magnitude increase in the combination of area coverage rate and resolution, as well as a 1-2 order of magnitude decrease in sensor system size and weight and power consumption. The Hyperspectral Framing system is planned for transition to the Air Force by FY 2010.

(U) Program Plans:

– Standoff Precision ID in 3-D (SPI-3D)
FY 2007 Accomplishments:
-- Initiated preliminary design of components for integration into a Multi-spectral Targeting System (MTS) turret and flight testing of selected critical design elements.
FY 2008 Plans:
-- Complete design for integration into MTS turret.
FY 2009 Plans:
-- Critical Design Review and fabrication of flight sensor components and flight system development.

– Advanced Optical Sensing
FY 2007 Accomplishments:
-- Investigated approaches for producing large aperture imaging systems with constrained size.
-- Explored uses of adaptive optics to provide optical corrections for multiple sub-apertures.
FY 2008 Plans:
-- 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.
FY 2009 Plans:
-- Integrate into test vehicle.
-- Conduct flight experiments for video windows and video tracking.
-- Transition system to Services for production and fielding.

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– Large Area Coverage Search-while-Track and Engage (LACOSTE)
FY 2007 Accomplishments:
-- Developed objective system concepts enabling wide-area stand-off sensor for urban tactical-grade ground target tracking.
-- Developed electroptical infrared electronically scanned sensor components.
FY 2008 Plans:
-- Lab test the sensor parameters against measured urban data.
-- Develop optical tracking algorithms.
-- Design and develop scaled objective system.
FY 2009 Plans:
-- Manufacture and integrate the LACOSTE sensor components.
-- Conduct a rooftop demonstration of a large cone-angle electronically scanned sensor in an urban environment.

– Spatially Processed Image Detection and Ranging (SPIDAR)
FY 2009 Plans:
-- Initial assessment of the performance of the current system configurations and systems analysis of long-range, high-resolution imaging applications.
-- Identify the trade space for considering multi-aperture receivers and illuminators in the system designs.
-- Define and detail performance of underlying key component technologies (including stable, high-power laser sources, high-speed imaging focal planes and image processing analysis.).
-- Develop conceptual system designs to achieve desired system performance.

– Hyperspectral Framing
FY 2009 Plans:
-- Detailed design of hyperspectral sensor package.
-- Parallel processing algorithm development.
-- Laboratory demonstration of breadboard system.

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	FY 2007	FY 2008	FY 2009
Synthetic Aperture Ladar for Tactical Imaging (SALTI)	13.689	14.000	26.000

(U) 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 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. 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 SALTI program has produced the first-ever synthetic aperture LADAR images from aircraft. 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 2012.

(U) Program Plans:

FY 2007 Accomplishments:

- Completed sensor package and ground testing.
- Conducted flight testing in various operational environments.

FY 2008 Plans:

- Develop lasers for higher power and higher bandwidths to support Long Range Demonstration (LRD).
- Characterize propagation through the atmosphere under operational conditions to assess long range operational performance.
- Generate and modify system design to support LRD.

FY 2009 Plans:

- Commence fabrication of critical subsystems to increase transmit power and telescope aperture.
- Repackage to reduce size and weight.
- Increase field-of-regard to allow forward look angles and accommodate aircraft roll and pitch.
- Develop real-time onboard processor and test critical subsystems.
- Test and characterize SALTI performance against diverse target sets in representative scenarios.
- Modify system design to support installation and testing in a pod.

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	FY 2007	FY 2008	FY 2009
Ground Targeting Sensors	15.815	17.540	17.602

(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 will develop 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 images that are superior to 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 Special Operations Forces in FY 2011.

- 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

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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 3-D 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 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). The obscurants 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 sufficent bandwidth and fast enough pulse rise time to create transient-like propagation characteristics in an aerosol cloud. This effort is planned for transition to the Navy and Air Force by FY 2012.

(U) Program Plans:

– SandBlaster
  FY 2007 Accomplishments:
  -- Completed full scale lidar testing of helicopter dust cloud penetration, and landing zone imaging.
  FY 2008 Plans:
  -- Complete Millimeter-Wave Radar development.
  -- Complete synthetic vision development.
  -- Complete advanced control laws.
  -- Complete sensor fusion engine.
  -- Complete development system integration and flight testing to demonstrate capabilities and performance.
  -- Integrate the system and demonstrate capabilities.
  -- Transition to the Services at completion.

– Super-Resolution Vision System (SRVS)
  FY 2007 Accomplishments:
  -- Established baseline soldier performance in turbulent atmospheres.

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-- Conducted field experiments to obtain data for algorithm development.
-- Developed image formation algorithms.
-- Tested image formation algorithm performance in controlled field experiments.
-- Designed prototype system.

FY 2008 Plans:
-- Investigate optimal control algorithms and implementation.
-- Complete prototype design; fabricate brassboard system.
-- Conduct field experiments and testing to optimize system performance.

FY 2009 Plans:
-- Complete fabrication and testing of soldier portable prototype.
-- Conduct demonstration and testing of prototype systems.
-- Modify design based on experiments and testing to support transition.

– Polar Bear

FY 2008 Plans:
-- 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.

FY 2009 Plans:
-- 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 and Clouds (SWIF)

FY 2008 Plans:
-- Develop imaging algorithms.
-- Conduct modeling and simulation to optimize system range and resolution.
-- Design scanning and imaging system for fast image formation in a wide field of view.
-- Conduct experiments under various scattering and absorption conditions to characterize optical link budget.

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-- Demonstrate imaging algorithm performance in controlled conditions.

FY 2009 Plans:

-- Design prototype system.
-- Test brassboard system in various operating conditions.
-- Develop prototype system.
-- Conduct environmental performance testing of prototype system.

	FY 2007	FY 2008	FY 2009
Soldier-borne Sensor Technology	15.273	9.046	11.997

(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:

- 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 would be able to observe, track, and laser designate the target as required, using a single device. This device would 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 also survives 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 as well as technologies that could assist snipers and spotters. This technology is expected to transition to the Army.

- 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

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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 will build upon technology investigated under the HPLD program and provide optical techniques to correct for crosswinds on ballistic objects. The C-WINS System will develop 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.

- The Laser Geospatial Referencing (LGR) system will 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 provides 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. LGR technology could dramatically reduce the time required for targeting existing firepower in the form of man-portable missiles, light armor, tanks, artillery and ground attack aircraft. LGR technologies will be transitioned to the U.S. Army and Marine ground forces, and U.S. Air Force and Army Airborne Targeting Systems in FY 2013.

- 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 by FY 2011.

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(U) Program Plans:

– High Precision Long Range Laser Designator/Locator (HPLD)
FY 2007 Accomplishments:
-- Completed image resolution & dance data analysis.
-- Developed signal processing technologies and algorithms to achieve high resolution imaging and reduce laser beam dance and wander.
-- Built and demonstrated target-in-the-loop adaptive optics ability to achieve high resolution laser pointing and imaging of small targets.
-- Developed atmospheric turbulence statistical model and investigated commercial off-the-shelf (COTS) lasers to test alternative concepts by modeling.
-- Developed system concepts for snipers and spotters that rely on tracking the aerosol motion resulting from crosswind over time.
FY 2008 Plans:
-- Demonstrate the feasibility of measuring crosswind and turbulence.
-- Investigate technology solutions to mitigate the effects of weather on sighting systems.

– Omni-Directional Flash & Launch Detection, Positioning, Classification and Observation System (MEGA)
FY 2007 Accomplishments:
-- Developed and demonstrated IR sensor prototype.
-- Developed and demonstrated stationary omni system.
-- Developed and demonstrated mobile platform omni system.
FY 2008 Plans:
-- Integrate mobile system with vehicle and demonstrate in series of field tests.

– Crosswind Sensor System for Snipers (C-WINS)
FY 2009 Plans:
-- 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.
-- Demonstrate system capability to correct crosswind effects on ballistic trajectory.

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-- Develop transition and manufacturing plans.

– Laser Geospatial Referencing (LGR)
FY 2009 Plans:
-- Complete analysis of radiometric constraints and the available technology paths to meet the program objectives.
-- Complete limited measurements of narrowband, wide field of view filters, and snapshot "shutters" suitable for the system as envisioned in turret and targeting pod configurations.

– Sensor Tape
FY 2009 Plans:
-- Develop jet-printing processes required for printed sensors, printed electronics and printed memory components.
-- Develop printed pressure, acceleration, light and acoustic sensors.
-- Develop and demonstrate proposed sensors and communications capability in controlled laboratory experiments.
-- Integrate modules into a complete first generation prototype blast dosimeter.

(U) Other Program Funding Summary Cost:

- Not Applicable.