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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	0.000	201.917	189.452	200.088	221.894	220.919	222.919	221.919
Surveillance and Countermeasures Technology SEN-01	0.000	67.236	58.957	70.058	83.388	85.456	85.956	85.956
Sensors & Exploitation Systems SEN-02	0.000	134.681	130.495	130.030	138.506	135.463	136.963	135.963

(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. This program element and the projects funded within it were created in accordance with congressional intent in the FY 2005 DoD appropriations bill. Prior year funding was budgeted in PE 0603762E, Projects SGT-02, SGT-03, and SGT-04.

(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 and strategic advantage, and the ability to deny and deceive enemy sensor systems.

(U) Additionally, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats. These technology developments are embodied in the following programs: Rescue Transponder; NUCTRAC; Building Structure and Activity Assessment; Surveillance and Threat Neutralization in Urban Environments; Counter Underground Facilities; Hostile Fire Indicator; RF MEMS Improvement; Low Cost Cruise Missile Defense; and Integrated Sensor Is Structure (ISIS).

(U) The Sensors and Exploitation Systems project develops and demonstrates advanced sensors, and exploitation technologies. These efforts provide warriors 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-

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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. These needs are addressed by the following programs: Advanced Exploitation Systems Technology; Network Centric Sensing and Engagement; Advanced Optical Sensor Technology; and Advanced Radar Sensor Technology.

(U) **Program Change Summary:** *(In Millions)*	**FY 2005**	**FY 2006**	**FY 2007**
Previous President's Budget	199.873	186.554	190.138
Current Budget	201.917	189.452	200.088
Total Adjustments	2.044	2.898	9.950

Please note that this program element has been newly created from portions of PE 0603762E. The *Previous President's Budget* amount reflects projects SGT-02, SGT-03 and SGT-04 previously funded in that PE.

Congressional program reductions	-4.856
Congressional increases	6.900
Reprogrammings	0.000
SBIR/STTR transfer	0.000

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(U) Change Summary Explanation:

FY 2005	Increase reflects a congressional adds for the Sandia Intelligent Systems and Robotics Center, 360 Degree Portable Surveillance and Reconnaissance Unit and Wireless Vibration Sensor Initiative offset by congressional reductions for the ISIS program and undistributed reductions.
FY 2006 - 2007	Increase reflects minor shifts in program pricing and phasing.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Surveillance and Countermeasures Technology SEN-01	0.000	67.236	58.957	70.058	83.388	85.456	85.956	85.956

(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. This program element and project were created in accordance with congressional intent in the FY 2005 DoD appropriations bill. Prior year funding was budgeted in PE 0603762E, Projects SGT-02 and SGT-03 and is noted in a memo entry in each program below.

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Counter-Underground Facilities	(15.300)	18.000	14.000	14.000

(U) 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. This program began by developing validated phenomenological models

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for a range of 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. One concept under development, the Deployable Unattended Ground Sensor System (DUGSS), will demonstrate 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. Another concept, the Low-Altitude Airborne Sensor System (LAASS), will demonstrate the use of airborne EM, acoustic, and gravity sensors to rapidly find UGFs and map out their backbone structure. 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 are planned for transition to the United States Special Operations Command, the Defense Intelligence Agency and the Air Force in the FY 2008 time frame.

(U) Program Plans:

- Completed signature data collection and characterization of geophysical site properties of UGFs.
- Completed model validation for seismic, acoustic, electromagnetic and effluent signatures and backgrounds and for effluent modeling tools.
- Evaluated concepts for effluent-based vent hunting and cave exploration, and developed candidate sensor designs for effluent-based characterization.
- Demonstrated functional prototype of multi-mode/multi-node ground sensor system, using clutter-limited sensors.
- Demonstrated feasibility of rapid, airborne surveillance and mapping of UGF structures.
- Developed component technologies for deployable systems, including low-mass coupling of seismic vibration sensors, site-adaptive non-line of sight communications, and improved deployable EM and gravity sensors.
- Conducted gravity gradiometer sensor and clutter performance measurements.
- Determined limits of performance of LAASS vs. altitude, sensor performance, and dwell time on target.
- Develop designs and performance predictions for prototype LAASS sensor payloads (EM, acoustic, and gravity) for UAV platform.
- Integrate LAASS sensor payloads onto low-altitude UAV platform and develop optimum flight pattern strategy.
- Demonstrate LAASS prototype system in rural and urban environments.

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	FY 2004	FY 2005	FY 2006	FY 2007
Digital Radio Frequency Tag (DRAFT)	(8.500)	3.375	0.000	0.000

(U) The Digital Radio Frequency Tags program will develop a flexible, potentially low cost technology to allow radars (Moving Target Indicator (MTI) and Synthetic Aperture Radar (SAR)) to receive data from ground devices. This program will develop a small, lightweight and affordable RF Tag for data exfiltration from unattended ground sensors and for communication with vehicles and personnel throughout the battlespace. This is particularly useful for the identification and location of coalition units. Other advanced tag capabilities will be investigated and developed, adding additional communications capabilities to the tags for enhanced interoperability with combat identification and communications systems. These added capabilities will give the tags dual-mode capability: to function as a tag when radar is present, or to function as a more conventional radio beacon device when radar is not available. Additionally, small-scale tag variations will be considered for other missions, including dismount and non-cooperative red-target tracking, with the net effect of substantially enhancing situational awareness and combat identification advantages for U.S. forces in conventional and unconventional ground operations. The DRAFT program is planned for transition to the Army and to the Marines; anticipated completion by FY 2005.

(U) Program Plans:

- Complete 5 baseline radar tag prototype units.
- Complete design of advanced tag concepts.
- Conduct laboratory device testing and characterization.
- Conduct airborne field tests and user demonstration.
- Complete dual-mode tag communicator design.
- Demonstrate dual-mode tag communicating on SATCOM waveform.
- Develop dismount/red tag prototypes and conduct laboratory device testing and characterization.

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	FY 2004	FY 2005	FY 2006	FY 2007
Rescue Transponder	(2.200)	6.000	2.000	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 Joint Personnel Recovery Activity at the conclusion of Phase 3 that is anticipated to be completed by FY 2006.

(U) Program Plans:
- Develop tags which enable the user to be identified and localized by airborne or advantaged receivers.
- Design a custom digital and microwave integrated circuit to allow miniaturization.
- Build and test prototype tags, devices and transmitters and author viable manufacturing plans.
- Demonstrate the military utility of RT to transition partners.

	FY 2004	FY 2005	FY 2006	FY 2007
Building Structure and Activity Assessment (Formerly Threat Character of Buildings)	(0.000)	5.000	5.000	9.000

(U) This program will develop 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 can be used to image static structures directly. Doppler processing of radar signals can be used to find 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 may also provide relevant mapping information and indications of floor loading. Multipath and propagation effects can be modeled and iteratively compared with

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hypotheses of building structures to provide 3-D building maps and large concentrations of metal materials like weapons. This program will develop 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. In addition, it will demonstrate technologies to monitor the integrity of building envelopes, to identify a breach of previously sealed/secured buildings and to identify previously hidden above and below-ground connections between buildings; approaches include pressure and power-line monitoring as well as the use of tracer gases deployed by hand or by robotics, such as multiple miniature search and rescue probes consisting of simple ball-like robots with rolling and hopping capability for building and rubble penetration. Transition to the Army's PEO Soldier and United States Special Operations Command is planned for FY 2008.

(U) Program Plans:
- Evaluate 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.
- Design, build, and test prototypes for use in full-scale demonstration.

	FY 2004	FY 2005	FY 2006	FY 2007
Surveillance and Threat Neutralization in Urban Environments	(0.000)	4.000	4.000	6.000

(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; and multi-mode integrated acoustic- and radar-based systems to backtrack to the source of fire. Neutralization technologies include targeted RF jamming of triggers; techniques to cause incomplete detonation of explosives; portable fast-erecting blast shields; and technologies to non-destructively and reversibly control urban access routes.

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

	FY 2004	FY 2005	FY 2006	FY 2007
Nuclear Facilities and Materials Tracking Assessment (NUCTRAC)	(0.000)	0.000	5.000	9.000

(U) The goal of the Nuclear Facilities and Materials Tracking and Assessment (NUCTRAC) program (continuation of advanced sensor processing studies initiated under PE 0602702E, Project TT-06, Advanced Tactical Technology) is to develop new technologies and systems that advance and enhance DoD capabilities in the area of hostile nuclear activities. The short-term goal of this effort is to solicit designs for the detection of fissile and radioactive materials, weapons programs, intact weapons and potential precursors for production of nuclear Weapons of Mass Destruction (WMD). The long-term goal of this effort is to enable robust detection of covert nuclear programs, nuclear weapons or materials en route to the United States, protection of U.S. interests overseas, and improvement in monitoring and inspection regimes. Specific objectives of NUCTRAC are to apply technology advances in computing, information processing, data fusion, low cost manufacturing, telecommunications, nanotechnology, robotics, signature detection, remote interrogation, facility characterization, mobile sensors, autonomous radiation detection technology and other recent advances to the detection of fissile materials, nuclear weapons and programs.

(U) Program Plans:
- Solicit detector concepts and develop to a level usable in Phase II development.
- Develop NUCTRAC preliminary design, risk management plan, and technology and system maturation plan.
- Develop sufficient system concept fidelity to validate program goals and objectives.

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	FY 2004	FY 2005	FY 2006	FY 2007
Low-Cost Cruise Missile Defense (LCCMD)	(12.740)	10.000	6.450	0.000

The LCCMD program will design, develop, demonstrate and transition an affordable electronically scanned array (ESA) seeker for use on a missile interceptor system to defeat unsophisticated air vehicles. Unsophisticated air vehicles are affordable, can be procured in large numbers to overwhelm U.S. defenses and provide a credible long-term threat to both civilian population centers and military targets. To reduce the cost of defending against such threats, it is crucial to reduce the cost of the guidance and control sections of defensive weapons. The LCCMD program will enable this through analyses, laboratory testing and field-testing of an all-weather seeker costing less than fifty thousand dollars in production. The program has pursued six novel concepts and is presently focused on the maturation and demonstrations of radar seeker solutions employing active ESA concepts using low cost single-chip transmit/receive modules. The LCCMD technology is planned for transition to the Army's PEO-ASMD at the conclusion of Phase III, which is anticipated to be completed during FY 2006.

(U) Program Plans:

- Built and tested active ESA antenna.
- Established Memorandum of Agreement transitioning active ESA to the U.S. Army partner for completing seeker integration, testing and performance analysis.
- Fabricated seeker back-end and integrated with ESA seeker antenna in preparation for ground or flight test.
- Conducted ground and flight testing.
- Integrate seeker with U.S. Army demonstration interceptor.
- Conduct end-to-end system performance via captive carry flight testing.

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	FY 2004	FY 2005	FY 2006	FY 2007
Integrated Sensor Is Structure (ISIS)	(8.800)	11.000	18.000	26.058

(U) The 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 100's 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 AMTI (600km) and GMTI (300km) operation; 12+ months of autonomous, unmanned flight; 100's 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 and the Missile Defense Agency at the conclusion of Phase III that is anticipated to be completed by FY 2009.

(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.
- Develop, mature, and demonstrate lightweight technologies for system integration (i.e. high-energy density batteries, electronic circuits on thin-film barrier materials, advanced multi-purpose airship hulls, regenerative fuel technologies).
- Design and simulate new radar modes: tracking air and ground targets through the clutter notch; detection and response to rockets, artillery, and mortars (RAM); detection of dismounted enemy combatants; and "track-all-the-way" fire-control.
- Design, build and demonstrate a fully-operational scaled flight system demonstrating complete system integration over an extended period (~3 months).

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	FY 2004	FY 2005	FY 2006	FY 2007
RF MEMS Improvement	(9.000)	8.861	0.550	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 will extend lifetimes, develop inexpensive packaging techniques, and enhance RF performance of RF MEMS switches to allow use in devices such as phase shifters, reconfigurable apertures, and tunable filters. The RFMIP program is anticipated to transition 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:

- Develop process improvements, supported by predictive performance models, in competing MEMS fabrication and packaging techniques.
- Perform six design and testing iterations of packaged MEMS.
- Demonstrate ability to fabricate low-cost, low-loss, long life MEMS switches meeting DoD requirements.
- Demonstrate reliable accelerated lifetime tests for fast determination of switch reliability pursuant to further lowering the cost of such devices.
- Demonstrate fully integrated switch circuits (e.g., fully integrated phase shifters, switchable filters) with substantially better performance than discrete switch approaches.
- Demonstrate integration of RF MEMS switches together with integrated transistor circuits so as to realize compact, single-chip systems.

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	FY 2004	FY 2005	FY 2006	FY 2007
Hostile Fire Indicator (HFI)	(0.000)	0.000	3.957	6.000

(U) The Hostile Fire Indicator (HFI) program is an airborne extension of the Boomerang Rapid Response program that will 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 will 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. This information can be relayed to the pilot, other friendly aircraft in the area, and mission planners and commanders for effective evasion, counter-fire, or follow-on engagement. The key technology element required for HFI is an advanced passive electrostatic sensor system derived from the same technology developed for stand-off electrocardiograms. The sensors are extremely small, lightweight, and low cost.

(U) The principle technical challenge in the HFI program is the effective integration and demonstration of the sensor net and processing system into an operating aircraft under realistic operating conditions. This program will be executed in conjunction with United States Special Operations Command (USSOCOM) and U.S. Army rotorcraft aviation organizations, including U.S. Army Special Operations Command (USASOC) -directed live-fire evaluations with an HFI-enabled aircraft as the final objective evaluation and demonstration. The HFI technology is planned for transition to USSOCOM and USA SOC at the conclusion of Phase 2 that is anticipated to be completed by FY 2007.

(U) Program Plans:

- Measure background noise on two U.S. Army and four SOF helicopters.
- Demonstrate 1000m downrange projectile detections.
- Optimize signal processing for the operational on aircraft electromagnetic noise environment.
- Demonstrate 10m cross-range bullet detection capability.
- Demonstrate projectile source location capability.
- Demonstrate full HFI capability on unmanned a full-scale model under live fire conditions.

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	FY 2004	FY 2005	FY 2006	FY 2007
Affordable Large Array (ALA)	(2.100)	0.000	0.000	0.000

(U) The Affordable Large Array (ALA) program has developed ultra-low cost, lightweight, and low-power density X-Band transceivers and related technologies for potential use in conjunction with very large but foldable and easily transportable antenna apertures. The technical challenges addressed under this program include the development of single chip transmit/receive modules with very low overhead power, (efficient and lightweight), techniques for distributing wideband RF, control signals, and DC power throughout the large arrays, and methods for dynamically calibrating these large flexible arrays. Other potential applications of ALA technologies include easily transportable, less expensive Ground Based Radar systems and aerostat-based systems for observing very low flying targets.

(U) Program Plans:
- Conducted studies and experiments to develop alternative array feed technologies that are applicable to very large arrays.
- Conducted power-aperture trade studies to determine the appropriateness of these technologies for applications including ground-based radars, radars for mid-course cruise missile defense and airborne low-power-density, large-scale radars.
- Completed testing of prototype transmit/receive (T/R) cells fabricated in SiGe, InP, and GaAs.

	FY 2004	FY 2005	FY 2006	FY 2007
Wireless Vibration Sensor Initiative	0.000	1.000	0.000	0.000

(U) Continues support of the development and qualification of open system architecture wireless sensor technology.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Sensors and Exploitation Systems SEN-02	0.000	134.681	130.495	130.030	138.506	135.463	136.963	135.963

(U) Mission Description:

(U) The Sensors and Exploitation Systems project develops and demonstrates advanced sensors, and exploitation technologies. These efforts, along with those in Project SEN-01 provide warriors 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. These needs are addressed by the following programs: Advanced Exploitation Systems Technology, Network Centric Sensing and Engagement, Advanced Optical Sensor Technology, and Advanced Radar Sensor Technology. This program element and project were created in accordance with congressional intent in the FY 2005 DoD appropriations bill. Prior year funding was budgeted in PE 0603762E, Project SGT-04 and is noted as a memo entry in each program below.

(U) Program Accomplishments/Planned Programs:

	FY 2004	FY 2005	FY 2006	FY 2007
Advanced Exploitation Systems Technology	(47.007)	42.098	39.182	38.463

(U) The Advanced Exploitation Systems Technology program develops semiautomatic methods to interpret and exploit sensor data. The objective is to detect and identify military threats. Data sources include national, theater and, organic surveillance and reconnaissance systems. Critical performance issues are timeliness, accuracy, error rates, and interpretation workload. The program addresses the challenges of target acquisition and tracking under restrictive rules of engagement. The technology applies advanced signal processing and machine vision to leverage advances in sensor capabilities. Initiatives in this program include the following:

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- Frequency-Diverse Spatial/Spectral Sensor Exploitation develops methods to better utilize advanced sensors. The initiative encompasses high-resolution multispectral, multipolarization, radio frequency, and electro-optical and active optical sensors. The program significantly improves mapping, terrain characterization, target detection, and situational awareness. The technology explores applications for both medium- and high-altitude deployment and permits fusion, automated exploitation, and visualization of products from diverse classes of sensors. These sensors and processing techniques enable commanders to enjoy wide-area detection, characterization, and geolocation information along with application to facilities, vehicle, and dismounted targets in both tactical situation awareness and strategic indication and warning. These tools support rapid mapping and terrain characterization support in near-real time for support of robotic and manned maneuver forces.

- The National/Tactical Exploitation (NTEX) initiative develops technologies to locate and identify enemy air defense units. NTEX uses multi-source imagery and data from both National Reconnaissance systems and tactical sensor assets. Under a DARPA Memorandum of Agreement with the National Geospatial-Intelligence Agency (NGA), the project places researchers in facilities with access to real data and analysts managed by the "Geospatial Intelligence Advancement Testbed" project at NGA. These researchers submit their sensor exploitation developments for rapid assessment by operational analysts using real world data. NTEX builds upon technologies developed under the DARPA Semi-Automated IMINT Processor Advanced Concept Technology Demonstration. The program demonstrates increased capability to model, detect, and locate air defense targets and surface threats, including those that have been denied, modified, or have yet to be modeled. DARPA established an MOA with the Night Vision and Electronic Sensors Directorate for this program in August 2004. The NTEX technology is planned for transition to an operational partner at the conclusion of Phase III anticipated to be completed by FY 2006.

- Video Verification and Identification (VIVID) develops technology to automate moving target strike operations for unmanned aerial vehicles (UAVs). 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 investigates 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 track multiple vehicular targets through dense traffic in military areas of operation overseas and supports target area searches for non-combatants and "no-strike" entities, to mitigate collateral damage. VIVID technologies significantly advance the capabilities of video surveillance and moving target strike for numerous military missions, including military operations in foreign urban areas. DARPA is

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establishing an MOA with the Air Force and Navy for this program. The VIVID technology is planned for transition at the conclusion of Phase II which is anticipated to be completed by FY 2007.

- Tactical Sensor Network Technologies (TSNT) 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.

- The Exploitation of 3-D Data (E3D) initiative develops techniques for rapidly exploiting 3-D sensor data. Such data is proliferating from growing numbers of advanced sensors, such as LADAR and IFSAR. The data represent a rich resource for use in precision target identification. E3D demonstrates that the target identification value of 3-D information greatly surpasses that of 2-D image-based methods. Program effort consists of three modules: (1) The Target Recognition module investigates the object recognition process; (2) The Target Acquisition module develops methods based on search of a local 3-D volume for possible targets; and (3) The Modeling module enhances identification methods based on detailed shape analysis. The resulting software tools are designed to be integrated into numerous ground stations to receive 3-D sensor data. The E3D technology is planned for transition to the Army and the Joint Precision Strike Demonstration at the conclusion of Phase IV anticipated to be completed in FY 2005.

- The Dynamic Tactical Targeting (DTT) initiative 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 (TSTs). 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 enable multi-scale estimation of 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 TSTs.

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- The All-Source Target Characterization initiative 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 discriminants. 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.

- The Automatic Target Recognition Technology thrust develops new approaches to characterize targets in high volume sensor data with minimal human participation and supports very large sets of targets (thousands of target types) with high identification performance and very low false alarm rates. The program develops modeling methods to account for target variability, caused by partial damage, design difference, or equipment loaded onto the exterior of the vehicle and will support interaction with humans to supply operational context, guide hypothesis development, and adapt models. While developing techniques for in-the-field training of models, signatures, and scoring parameters, it will identify vehicle-specific signatures and develop new target fingerprinting techniques. Finally, new methods to assist humans in achieving precise identification of ad hoc poorly defined targets will be developed. The program supports rapid and accurate detection, recognition, and identification of targets in high volume sensor imagery and enables a dramatic reduction in sensor-to-shooter timelines, supporting dynamic target engagement.

(U) Program Plans:

– Frequency-Diverse Spatial/Spectral Sensor Exploitation.
  -- Design, analyze, and assess new concepts for exploitation of advanced sensors: RF, EO/IR and active optical frequency-agile spatial/spectral/polarimetric.
  -- Perform phenomenological investigations to assess target signature stability, variability and separability.
  -- Develop prototype tools for exploiting signatures.
  -- Design, develop, and evaluate brassboard sensor hardware.
  -- Evaluate system performance under controlled environments.
  -- Design, develop, and evaluate form, fit, and function sensor hardware.
  -- Integrate on the aircraft and evaluate performance in flight test over realistic targets and large clutter sets.

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- National/Tactical Exploitation.
  - -- Demonstrate the ability to recognize components of specific air defense units using automated processing of national/tactical sensor data.
  - -- Demonstrate the ability to model targets observed from sensor views, then locate and identify those targets autonomously in subsequent imagery.
  - -- Demonstrate the ability to model denied and expedient targets from a few sensor views, then locate instances of those targets that would be overlooked by analysts in a real-world situations.

- Video Verification of Identity.
  - -- Develop techniques to automate detection, classification, and tracking of enemy, mobile, surface targets in visible and infrared motion imagery acquired by unmanned air vehicles.
  - -- Develop automated techniques to detect moving vehicles and unintended casualties in the vicinity of an impending weapon strike.
  - -- Demonstrate integrated, semi-automated engagement of hostile surface targets with precision weapons guided by data from video sensors on airborne platforms.

- Tactical Sensor Network Technologies.
  - -- Develop algorithms for distributed situation assessment at all nodes of a networked group of sensors.
  - -- 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.
  - -- Provide additional synthetic data and collect advanced laser radar (LADAR) data for research and development modules.
  - -- Acquire and refine 3-D models of potential target vehicles.
  - -- Develop tools to locate, classify, identify, and characterize the operational states of ground targets using data from 3-D sensors (e.g., LADAR) making use of structural models of candidate target geometries.
  - -- Proliferate structural models to encompass hundreds of candidate target types.
  - -- Expand capabilities to perform precision recognition in the presence of articulation and obscuration.
  - -- Improve performance of real-time processing.

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-- Extend model-based vision technologies to classify, identify, and characterize the operational state of ground targets from other sources of 3-D sensor data.

– Dynamic Tactical Targeting.
-- 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.
-- 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 use in field demonstrations.

– 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.

– Automatic Target Recognition Technology.
-- Obtain a constant supply of data from field and developmental sensors, covering multiple target types in numerous environmental settings.
-- Obtain or estimate ground truth for those data to provide a foundation for periodic performance assessments.
-- Extend existing performance analyses to provide bounds on detection, identification, and fingerprinting performance for thousands of vehicle types.

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-- Develop model generation, model update, detection, recognition, identification, and fingerprinting algorithms based on a range of technical approaches.
-- Periodically assess technologies on the field data, computing statistically significant estimates of performance to compare against the performance analyses.

	FY 2004	FY 2005	FY 2006	FY 2007
Network Centric Sensing and Engagement	(29.891)	28.144	39.683	43.843

(U) The Network Centric Sensing and Engagement Program develops technology and tools to support precise situational awareness, rapid targeting, and precision engagement through the exploitation of systems of networked sensors. 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 ground-based fixed and mobile 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. Initiatives in this program include the following:

- The Camouflaged Long Endurance Nano-Sensors (CLENS) initiative 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 Tactical Targeting Network Technologies (TTNT) initiative develops rapidly reconfigurable, affordable, robust, interoperable, and evolvable communications technologies. Resulting technologies support airborne network-centric targeting. Goals for the TTNT tactical network are: (1) reconfigurability in fractions of a second; (2) wideband capacity (10+Mbit/s) on demand; (3) near zero (2 milliseconds)

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latency for high priority messages; (4) complete interoperability with Link 16; and (5) cost effectiveness. This program addresses technical issues including physical waveforms and frequency allocations, fast security subsystems, and distributed network management. It is developing novel digital processing techniques to eliminate the need for centralized network synchronization. TTNT is pursuing an omni-antenna-based approach with a self-adaptive, channel-sensing, multiple user access protocol. It employs spread spectrum waveforms optimized for rapid carrier acquisition, featuring powerful turbo code error detection and correction. This physical layer provides well-integrated security architecture. The network architecture is designed to exploit commercial-off-the-shelf technology wherever possible. TTNT will incorporate Joint Tactical Radio System software defined radio standards. Performance in simulations and laboratory testing with bread-board equipment exceeds the current phase program goals. TTNT is designing and fabricating a full security architecture brass-board system. The program separately developed a novel Ku band directional antenna. The antenna promises 20+Mbit/s connectivity between intelligence, surveillance and reconnaissance assets, tactical aircraft, and small unmanned air vehicles using the Common Data Link family of radios. The TTNT technology is planned for transition to the Air Force, Army, Marine Corp, and Navy at the conclusion of Phase III, that is anticipated to be completed by FY 2006.

- The Rotorcraft SIGINT/COMINT Geolocation initiative develops network-based signal geolocation technology for rotorcraft application. The program enables collaborative interaction between multiple rotorcrafts (manned or unmanned) for mapping, location and engagement of RF emitters. This effort develops techniques to mitigate rotor blade induced multipath. It demonstrates appropriate receiver, signal processing and antenna technology, enabling ad hoc rotorcraft networks to rapidly characterize emitters.

- The Federated Object-level Exploitation (FOX) initiative assembles the results of image analyzers, target recognizers, and signal processors into a collection (federation) of situation estimates and describes objects of interest ranging from terrain, roads, and surface type to militarily significant vehicles, buildings, and people. The estimates enable prediction of future observables, enabling differences between the predictions and the observations to trigger change detection and analysis that updates the estimates. The estimates are maintained, in a consistent manner at multiple sites, distinguished by different areas of interest, target sets, and data sources. Technologies are evaluated on real-world data at experimental facilities colocated with operational analysts, and transition takes place incrementally as individual technologies mature.

- 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

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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 analysis to identify their support structures.

(U) Program Plans:

– Camouflaged Long Endurance Nano-Sensors.
  -- Develop a breadboard, ultra-wide, band radar micro-sensor for dismount detection and tracking.
  -- Design receiver nodes to process micro-sensor that detects into tracks and exfiltrates data.
  -- Develop tracking algorithms to consolidate range-only detects into contact tracks.
  -- Fabricate targeted form factor micro-sensors.
  -- Conduct ground demo with one receiver/processor and many micro-sensors.

– Tactical Targeting Network Technologies.
  -- Complete brassboard design and fabrication.
  -- Complete brassboard TTNT flight experiments and demonstrations at large scale.

– Rotorcraft SIGINT/COMINT Geolocation.
  -- Analyze interactions between threat signals and rotor blades.
  -- Validate analyses with tower tests.
  -- Build a prototype airborne system.
  -- Validate single-ship performance with flight tests.
  -- Interface prototypes to the inter-ship communications net.
  -- Demonstrate multi-ship operation in flight tests.

– Federated Object-level Exploitation.
  -- Acquire real-time access to data from all-source national and tactical sensors operating over an area of interest.
  -- Establish connectivity among a minimum of three testbed sites at which those data can be received.

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-- Build a baseline evaluation testbed by assembling best-of-breed technologies for site modeling, target recognition, and target tracking.
-- Create a design for a federated set of algorithms that allow multiple sites to construct various parts of a situation estimate.
-- Implement and test protocols for ensuring statistical consistency between estimates maintained at different sites.
-- Obtain data that can serve as ground truth for evaluating algorithm performance.

– Persistent Operational Surface Surveillance and Engagement
-- 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.
-- Deliver initial POSSE exploitation system to Iraqi theatre and provide technical support as required.
-- Implement planned enhancements and additions, and deliver to theatre in accordance with POSSE spiral development plan.

	FY 2004	FY 2005	FY 2006	FY 2007
Advanced Optical Sensor Technology	(21.464)	26.519	26.869	26.962

(U) The Advanced Optical Sensor Technology Program significantly improves warfighter situation awareness, surveillance, reconnaissance and targeting. The program exploits advancements in electro-optic, hyper spectral imaging, optical polarimetry, and advanced three dimensional active optic sensing. Initiatives in this program include the following:

- Standoff Precision ID in 3-D (SPI 3-D) develops an affordable sensor package capable of high-resolution 3-D images for confirmatory ID at long ranges. The sensor overcomes weapons-effects obscuration and penetrates foliage, camouflage, and cloud layers. The system provides intensity, range and polarization for each pixel in the field of view. The program conducts a series of ground, air and unmanned

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air vehicle demonstrations of standoff 3-D LADAR precision ID and track fusion techniques. The objectives are to provide: (1) rapid acquisition; (2) polarization exploitation; (3) intensity mapping; and (4) high range resolution. Results will provide commanders with significantly improved identification of enemy ground-moving targets. Demonstrations employ existing commercial-off-the-shelf optics, focal plane arrays and gimbals, combined with a novel polarization-to-range mapping technique. The SPI-3D technology is planned for transition to the Air Force at the conclusion of Phase III that is anticipated to be completed by FY 2008.

- The Synthetic Aperture Ladar for Tactical Imaging (SALTI) initiative will develop and demonstrate an airborne interferometric synthetic advanced laser radar (Ladar) imager capable of producing high-resolution three-dimensional imagery at long ranges. The ultimate SALTI system will combine the long-range day/night access afforded by conventional synthetic aperture radar (SAR) with the interpretability of high-resolution optical imagery and the exploitability of three-dimensional (3-D) imagery and fit within a tactical-sized package suitable for deployment on a long-range unmanned air vehicle such as the Global Hawk. 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 technology is planned for transition to the Air Force by FY 2007.

- The Video Exploitation for Precision Identification initiative leverages numerous video sensors being introduced into the battlespace, providing more persistent and ubiquitous sensing over larger areas of interest. This initiative explores new ways to enhance the performance of target recognition and site monitoring techniques through use denser data sets that exhibit high temporal and spatial sampling rates, long-term observation, and perspective diversity. Particular topics of interest include: (1) video data mining (e.g., extracting and representing behavior, representing and recognizing events and patterns of events, and characterizing patterns of object motion); (2) learning for recognition and monitoring, (e.g., learning object categories from stereo or video sequences and learning event and behavior normalcy models); (3) modeling-on-the-fly (e.g., creation of active models and models that use recent advances in camera modeling and extraction of geometric information and invariants); (4) novel sensing techniques (e.g., dense, inexpensive camera arrays, polarization-sensing video cameras, and novel image formation processes that could extract new or different types of information, such as imaging through foliage or walls); (5) innovative space-time visualization concepts (e.g., new approaches to 4D visualization or visualization using video flashlights or paintbrushes); and (6) new approaches to recognition (e.g., recognizing classes of objects, inferring and reasoning about function, using scene or site models to object identification or characterization, recognizing events, and using multi-view geometry, 3D curves, affine patches, or other invariant or semi-invariant techniques).

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- The High Precision Long Range Laser Designator/Locator (HPLD) initiative 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 develop new 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 over 5 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. DARPA established an MOA with the Night Vision and Electronic Sensors Directorate for this program in August 2004. The High Precision Long Range Designator/Locator technology is planned for transition to the Army and SOCOM by FY 2008.

- 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.

(U) Program Plans:

– Standoff Precision ID in 3-D.
  -- Develop and test brassboard of complete imaging system, including laser and Pockels cell elements.
  -- Determine accuracy and precision of ranging technique.
  -- Develop flight engineered system.
  -- Perform full-up ground tests from mountaintop test range.
  -- Integrate and demonstrate system from manned aircraft against moving targets.
  -- Integrate system into air vehicle and fully demonstrate against a variety of ground targets.

– Synthetic Aperture Ladar for Tactical Imaging.
  -- Develop a laser transmitter containing an extremely stable local optical oscillator and other oscillators, modulators and power amplifiers necessary to create the time-dependent waveform and power required for synthetic aperture imaging.
  -- Develop a multi-element detector array including analog and digital electronics for coherently reading all elements of the array.
  -- Integrate the detector array with an optical master oscillator to form a coherent receiver.

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-- Develop image formation processing algorithms to coherently combine multiple laser pulse returns and to compensate for platform motion during the collection of these multiple pulses.
-- Demonstrate the collection of optical synthetic aperture imagery from an airborne platform and that produces high-resolution 2D and 3D image products.
-- Characterize coherent infrared propagation through the atmosphere under operational conditions, to assess the feasibility of long range operation.

– Video Exploitation for Precision Identification.
-- Instrument an overseas military facility with a dense set of still and video sensors.
-- Regularly insert instrumented vehicles and soldiers into the ambient traffic and activities.
-- Select a broad set of relevant technologies and implement as software prototypes.
-- Evaluate prototypes based on their ability to reconstruct aspects of the instrumented vehicles and soldiers.
-- Select prototypes for integration into a real-time testbed.
-- Design, build, and operate a video exploitation testbed, providing regular feedback to technology developers.
-- Transition technologies to relevant acquisition programs for target identification, site characterization, and force protection.

– High Precision Long Range Designator/Locator (HPLD).
-- Build and demonstrate target-in-the-loop adaptive optics ability to achieve high resolution laser pointing and imaging of small targets.
-- Validate the pointing accuracy of eye safe integrated optics at targets in excess of 5 kilometers.
-- Design, build, and demonstrate an integrated HPLD 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
-- 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.

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	FY 2004	FY 2005	FY 2006	FY 2007
Advanced Radar Sensor Technology	(26.214)	32.020	24.761	20.762

(U) The Advanced Radar Sensor Technology program promises significant improvements in military sensor performance in situation awareness, surveillance, reconnaissance and targeting applications. Its emphasis is on surface targets and threats. Program efforts are focused 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 (GMTI) 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. Initiatives in this program include the following:

- The Wide Area All Terrain Change Indication and Tomography (WATCH-IT) initiative is developing real-time VHF/UHF synthetic aperture radar (SAR) automatic change detection and target discrimination technologies. WATCH-IT provides the commander with rapid, robust detection of threat systems in the open, under camouflage, and in foliage. The program features discrimination algorithms that examine change detections to determine if they have threat vehicle characteristics. Indications of change cue on- or off-board high-resolution sensors to perform target identification. WATCH-IT is designed to operate from platforms, such as high altitude unmanned air vehicles (UAVs). The technology will demonstrate high area-coverage rates with few false alarms. WATCH-IT provides commanders with a critical capability that currently does not exist. The program also develops techniques to extract 3-D vehicle images from multiple-pass polarimetric SAR imagery. This capability enables rejection of confusers (i.e., decoys, relocated vehicles that are not of military significance), thus greatly improves target classification/identification. DARPA established an MOA with the National Geospatial – Intelligence Agency for this program in September 2004. The WATCH-IT technology is planned for transition to the NGA at the conclusion of Phase II, anticipated to be completed by FY 2005.

- The Knowledge Aided Sensor Signal Processing and Expert Reasoning (KASSPER) initiative radically alters the fundamental "front-end" signal processing architectures of advanced military sensors. It accomplishes this through the real-time integration of a dynamic environmental knowledge database. Real-time "environmental awareness," absent in conventional systems, dramatically improves clutter and interference rejection and significantly enhances sensor products. Current radio frequency sensors with adaptive signal processing

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estimate the background interference using sample statistical estimation. This necessarily entails an explicit assumption of stationarity. However, sensors operating in real environments around the world demonstrate that this homogeneity assumption is not valid. The problem manifests itself in increased false alarms, decreased target detections, and substantially degraded minimal detectable velocities in GMTI systems. KASSPER leverages the advent of detailed databases and high fidelity models to address inhomogeneities and non-stationarity at the front end of adaptive signal processing systems. Key technologies include advanced algorithms and high-performance computing architectures capable of memory-intensive adaptive signal processing. The program includes data collections, and a real-time demonstration of its processing gains. The KASSPER technology is planned for transition to the Air Force during FY 2005.

- The Generation After Next Airborne Surveillance Radar (GAN) initiative will evaluate new concepts for wide area coverage airborne ground surveillance radar technology by exploiting wide-beam staring systems rather than narrow-beam scanning systems. This approach would overcome challenges associated with low revisit rates, limited concurrency of modes, low power efficiency, low resolution, and sensor management. It is hypothesized that by supporting several modes on the aperture concurrently, GAN could offer better than an order-of-magnitude improvement in radar productivity relative to current and emerging systems.

- The Tethered Ultra-Long baseline Sparse Aperture (TULSA) initiative is developing new means of exploiting single-ship airborne long-baseline sparse apertures. This initiative develops techniques for deploying, calibrating, powering, feeding and processing received signals from active end bodies deployed on long, towed tethers. TULSA also develops signal processing to support use of single-aircraft, towed long-baseline sparse arrays for: (1) emitter geolocation and (2) long baseline multi-static radar applications, such as GMTI multi-lateration. TULSA promises high-confidence geolocation of emitters from a single aircraft and provides commanders with characterization and targeting information for facilities, vehicles, and dismounted targets. The program also delivers tactical situation awareness and supports strategic indication and warning.

- The Networked Detection and Ranging (NetDAR) initiative is addressing an impending bandwidth crisis in radar. Commercial pressures on bandwidth usage will make it difficult for military radar systems to operate in peace time without interfering with or being interfered by other transmission sources. This initiative will explore technologies to turn this bandwidth crisis into an asset. By using signals of opportunity across the spectrum, systems will be developed that can passively exploit a multi-static and only transmit to augment the RF propagation environment. Multi-Input Multi-Output (MIMO) radar concepts will be developed that coherently integrate multiple signals to efficiently use the entire RF spectrum. This now makes all RF sources assets instead of interference sources. This will include adaptive waveform diversity and extending MIMO radar into airborne sources as a revolutionary approach to conventional multi-static radar.

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(U) Program Plans:

– Wide Area All Terrain Change Indication and Tomography.
  -- Collect data using low-frequency, high-resolution polarimetric SARs.
  -- Quantify the robustness of wide area change detection to factors, such as aircraft heading, depression angle, database aging, topography and terrain cover. Exploit initial target and clutter data collected at Camp McCain, MS and Fort Huachuca, AZ.
  -- Assess alternative change detection algorithms to determine the robustness to data variations, the computational requirements, and other factors impacting suitability for implementing WATCH-IT on an UAV.
  -- Quantify the probability of detection and false alarm rate for a range of operating conditions.
  -- Investigate methods to generate synthetic target signatures using software models or scaled frequency measurements.
  -- Demonstrate WATCH-IT using the Foliage Penetration (FOPEN) SAR Advance Technology Development (ATD) system. Demonstrate real-time, on-board change detection and high-speed discrimination processing in the ground station.
  -- Develop a system specification for a fully integrated WATCH-IT system.
  -- Develop, integrate, install, and flight test the WATCH-IT on a manned or unmanned aircraft.

– Knowledge Aided Sensor Signal Processing and Expert Reasoning.
  -- Developed advanced expert-reasoning algorithms using real and simulated data sets in non-real-time (offline) and real-time modes.
  -- Developed real-time, high-dimensionality KASSPER software.
  -- Conducted off-line KASSPER Constant False Alarm Rate & Radar (CFAR) demonstration.
  -- Defined high performance embedded computing architecture to enable rapid memory access; design, build, test, and demonstrate.
  -- Demonstrate KASSPER performance gains in real-time processing environment using real data sets.

– Generation After Next Airborne Surveillance Radar.
  -- Develop missions and concepts of operation to evaluate GAN sensor concepts.
  -- Outline basic functional requirements to support proposed missions and concepts of operation.
  -- Develop strawman concepts for GAN and evaluate their ability to satisfy the specified functional requirements.
  -- Establish basic technology requirements.
  -- Develop a roadmap outlining an objective GAN system and an investment strategy.
  -- Develop a GAN prototype system and demonstrate its effectiveness in field activities.

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– Tethered Ultra-Long baseline Sparse Aperture.
  -- Develop and demonstrate a multi-sensor localization concept.
  -- Develop and evaluate relative navigation concepts to achieve desired geolocation accuracy.
  -- Develop system and demonstrate the system capability against significant targets.

– Networked Detection and Ranging.
  -- Develop hybrid passive/active radar system concept.
  -- Quantify performance benefits of multi-input multi-output exploitation of full RF spectrum.
  -- Design, build, test, and demonstrate multi-sensor integration experiment.
  -- Demonstrate performance gains in real-time.

	FY 2004	FY 2005	FY 2006	FY 2007
360 Degree Portable Surveillance and ReConn Unit	(0.000)	2.400	0.000	0.000

(U) The 360 Degree Portable Surveillance and ReConn Unit project will design and fabricate an extremely large format video camera suitable for airborne reconnaissance by military forces in Iraq and elsewhere. The goal is to produce a 400-megapixel video camera – the world's largest. With suitable optics, such a camera will support the tracking of individual vehicles throughout a 10-km x 10-km area, or to enable moving target detection in a similar sized area. These capabilities have enormous potential to tip the scale in the battle against emplaced, and vehicle-borne improvised explosive devices (IEDs) and other asymmetric warfare scenarios.

(U) Program Plans:
– Create 48 M-pixel MegaSkyCam from modular components (digital focal panes, GPS and data links).
– Integrate eight MegaSkyCams to create the end device.
– Demonstrate detection and tracking algorithms on an array of processors to produce automated alerts.

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	FY 2004	FY 2005	FY 2006	FY 2007
Sandia Intelligent Systems & Robotics Center	(0.000)	3.500	0.000	0.000

(U) Fund selected research projects at the Sandia Intelligent Systems & Robotics Center.

(U) Other Program Funding Summary Cost:

- Not Applicable.