PE NUMBER: 0602204F
PE TITLE: Aerospace Sensors

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	77.172	86.405	78.804	93.839	96.715	97.226	99.677	0.000	0.000
2002	Electronic Component Technology	19.956	17.126	15.072	17.021	19.255	19.813	20.185	0.000	0.000
2003	EO Sensors & Countermeasures Tech	11.881	18.680	14.657	15.649	16.139	16.701	17.061	0.000	0.000
4916	Electromagnetic Tech	11.906	12.151	9.536	9.876	10.273	10.694	11.134	0.000	0.000
5016	Photonic Component Technology	3.191	2.889	2.878	2.157	2.187	2.369	2.541	0.000	0.000
5017	RF Processing for ISR Sensors	7.400	6.643	7.362	7.726	7.336	7.599	7.789	0.000	0.000
6095	Sensor Fusion Technology	12.670	12.131	13.246	15.626	16.267	16.781	17.146	0.000	0.000
7622	RF Sensors & Countermeasures Tech	10.168	16.785	16.053	25.784	25.258	23.269	23.821	0.000	0.000

Note: In FY 2003, space unique tasks in this PE, Projects 2002, 6095, and 7622, transferred to PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program develops the technology base for Air Force aerospace sensors and electronic combat. Advances in aerospace sensors are required to increase combat effectiveness by providing "anytime, anywhere" surveillance, reconnaissance, precision targeting, and electronic warfare capabilities. To achieve this progress, this program pursues simultaneous advances in: 1) generating, controlling, receiving, and processing electronic and photonic signals for radio frequency (RF) sensor aerospace applications; 2) electro-optical aerospace sensor technologies for a variety of offensive and defensive uses; 3) RF antennas and associated electronics for airborne surveillance, together with active and passive electro-optical sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; and 5) technology for reliable, all-weather surveillance, reconnaissance, and precision strike radio frequency sensors and electronic combat systems. Note: In FY 2004, Congress added $2.4 million for Three-Dimensional (3-D) Packaging Technology for High Speed RF Communication, $3.2 million for the Watchkeeper Ultra Wideband Demonstration, $3.0 million for the Center for Advanced Sensor and Communication Antennas, and $3.0 million for the General Purpose reconfiguration Signal Processors System. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary sensor, electronics, and electronic combat technologies.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.743	75.577	84.110
(U)	Current PBR/President's Budget	77.172	86.405	78.804
(U)	Total Adjustments	0.429	10.828	
(U)	Congressional Program Reductions		-0.030	
	Congressional Rescissions		-0.742	
	Congressional Increases		11.600	
	Reprogrammings	1.227		
	SBIR/STTR Transfer	-0.798		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 2002 Electronic Component Technology	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2002 Electronic Component Technology	19.956	17.126	15.072	17.021	19.255	19.813	20.185	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in photonic component technology moved from this project into this PE, Project 5016. Also in FY 2003, space unique tasks in this project transferred to
PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for radio frequency (RF) sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance (ISR), electronic warfare (EW), and precision engagement. The technologies developed include: solid state power devices and amplifiers; low noise and signal control components; high-temperature electronics; signal control and distribution; signal processing; multi-function monolithic integrated circuits; high-speed analog-to-digital and digital-to-analog mixed mode integrated circuits; power distribution; multi-chip modules; and high density packaging and interconnect technologies. This project also designs, develops, fabricates, and evaluates techniques for integrating combinations of these electronic component technologies. The project aims to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. The device and component technology developments under this project are military unique; they are based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, communications, EW, navigation, and smart weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System, radar, EW, and other ISR sensors.	3.858	2.606	5.107

(U) In FY 2003: Tested Gallium Arsenide and Indium Phosphide RF components (analog-to-digital converters, filters, mixers, etc.) inserted into radar and EW digital receiver modules against environment scenarios. Demonstrated a brassboard low-power (< 1.0W), silicon-on-sapphire based analog-to-digital converter and completed ground-level radiation testing in a space-qualified package. Laboratory tested a silicon-on-insulator mixed-signal (digital, RF, microwave, etc.) integrated circuit, for reconfigurable signal conversion.

(U) In FY 2004: Develop receiver architecture and components addressing issues specific to digital beamforming (DBF) systems, such as multiple channel coherence of multi, digital true time delay support, channel equalization, and array calibration. Evaluate in a relevant environment affordable Gallium Arsenide (GaAs) RF components (analog-to-digital converters, filters, mixers, etc.), together with the technology upgrade plan for Indium Phosphide (InP) RF components into radar and EW digital receiver modules.

(U) In FY 2005: Develop a DBF receiver architecture addressing issues specific to DBF systems, such as coherence of multiple channels, support for digital true time delay, channel equalization, and array calibration. Evaluate affordable

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**	

	DBF-specific Gallium Arsenide (GaAs) RF components (ADCs, filters, mixers, etc.) with the technology upgrade plan for Indium Phosphide (InP) RF components into radar and EW digital receiver modules.			
(U)				
(U)	MAJOR THRUST: Develop microwave technologies for advanced radio frequency (RF) apertures and phased array antennas used in military intelligence, surveillance, and reconnaissance (ISR) sensors.	3.350	2.298	0.824
(U)	In FY 2003: Developed and demonstrated robust components for L-band and X-band transmitter and receiver channels that operate with limited environmental controls and under severe electromagnetic stress.			
(U)	In FY 2004: Develop and demonstrate the proof of concept of transmit and receive (T/R) channels that are able to withstand strong undesired electromagnetic signals.			
(U)	In FY 2005: Develop and demonstrate the proof of concept of limited subarrays and advanced device technologies that are able to withstand extreme temperature and signal environments.			
(U)				
(U)	MAJOR THRUST: Develop integration and assembly technologies for high performance aerospace phased array sensors.	4.050	2.039	1.921
(U)	In FY 2003: Demonstrated X-band, flexible RF membrane-based sub-assemblies that enable integrating low-cost and low-mass transmitter and receiver channels at the subarray level.			
(U)	In FY 2004: Develop and demonstrate large area (>0.5 m2) active apertures based on flexible RF membranes that lower the assembly costs and mass over conventional phased arrays by an order of magnitude.			
(U)	In FY 2005: Develop and demonstrate the complex integration of multiple functions on flexible RF substrates for application on conformal surfaces such as those found on aerospace vehicles.			
(U)				
(U)	MAJOR THRUST: Develop signal control and low-power consumption components and techniques to reduce both power loss and power consumption for future radar, electronic warfare (EW), and ISR sensors.	4.310	2.738	4.477
(U)	In FY 2003: Characterized and matured micro-electro-mechanical systems wideband phase shifters for extended switch lifetimes. Reduced the power consumption of low-noise amplifiers while maintaining high linearity over wide bandwidths.			
(U)	In FY 2004: Fabricate subarrays with T/R channels that feature a five-fold power consumption reduction, while maintaining high linearity over wide bandwidths.			
(U)	In FY 2005: Develop new T/R channel technology using advanced semiconductor integration techniques.			
(U)				
(U)	MAJOR THRUST: Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment.	2.430	1.300	1.097
(U)	In FY 2003: Verified that these interconnects and components perform on rigid, flexible, and conformal assemblies of high density mixed-signal technologies (digital, analog, microwave and millimeter wave devices and components).			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

	Tested interconnects and components in both packaged (non-hermetic multi-chip modules) and package-less (bare-die-chip on board) forms.			
(U)	In FY 2004: Develop and demonstrate mixed-signal receiver/processor multi-functionality on flexible arrays using advanced two-dimensional and three-dimensional interconnects, and package-less protection schemes. Verify the electrical performance of these mixed-signal assemblies and validate their hermetic-like protective qualities.			
(U)	In FY 2005: Demonstrate and evaluate a two-fold decrease in the cost and size of the mixed-signal assemblies.			
(U)				
(U)	MAJOR THRUST: Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, radio frequency (RF), microwave, etc.) component development in both advanced and emerging electronic component technologies.	0.000	0.893	1.646
(U)	In FY 2003: Not Applicable. In FY 2003, this work was performed under the previous major thrust area.			
(U)	In FY 2004: Laboratory test breadboard silicon-on-insulator and silicon-on-sapphire signal conversion components designed for precise positioning, navigation, and other aerospace applications			
(U)	In FY 2005: Evaluate system-in-a-package/system-on-a-chip tool suite for the modeling, simulation, design, and characterization of mixed-signal (digital, RF, microwave, etc.) components developed for advanced mixed-signal technologies (silicon-on-insulator (SOI), Silicon Germanium (SiGe), Antimonides, Indium Phosphide (InP)). Test in a laboratory environment breadboard SOI and SiGe signal conversion components designed for narrow band (Global Positioning System, air moving target indication) aerospace applications.			
(U)				
(U)	CONGRESSIONAL ADD: Wireless Surveillance of Hostile Threats.	0.979	0.000	0.000
(U)	In FY 2003: Developed low-temperature, high-efficiency, small-scale fuel cells to generate power for wireless micro-sensor systems that will provide "anytime, anywhere" ISR capabilities against emerging hostile threats.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Fourier Transform-Infrared (FT-IR) Gas Analysis.	0.979	0.000	0.000
(U)	In FY 2003: Demonstrated FT-IR spectrometric gas analysis techniques for applications in controlling reactant gases generated during the vapor phase epitaxial growth of semiconductor films on substrates. These techniques will also be used to monitor gas concentrations in nanostructure growths for electronic and optical devices, and in the development of new approaches to detecting chemical and biological agents.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: 3-D Packaging Technology for High Speed RF Communication.	0.000	2.326	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Design, fabricate, and demonstrate proof-of-principle experimental 3-D microcircuit packages for high speed electrical and high-power thermal military sensor applications.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: General Purpose Reconfiguration Signal Processors System.	0.000	2.926	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Accelerate the development and transition of new on-board sensor signal processors for time-critical intelligence, surveillance, and reconnaissance applications in unmanned aerial vehicles.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	19.956	17.126	15.072

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 2003 EO Sensors & Countermeasures Tech	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2003 EO Sensors & Countermeasures Tech	11.881	18.680	14.657	15.649	16.139	16.701	17.061	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared (IR) portion of the spectrum. Related efforts include improvements in avionics integration, digital processing, analysis tools, and sensor architectures. One of the project's main goals is to improve EO and related technologies for the detection, tracking, and identification of non-cooperative and difficult targets, such as those obscured by camouflage. This project also develops the passive and active hyperspectral imaging sensors and algorithms needed to enable precision targeting in severe weather. These technologies are critical to future aerospace surveillance and targeting. Other project goals include advanced EO threat warning and countermeasures.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop technology for non-cooperative identification of airborne and ground-based platforms.	3.180	3.810	2.928

(U) In FY 2003: Conducted air-to-air and air-to-ground demonstrations of long-range combat identification (CID) sensors. Tested range-resolved coherent image processing and extraction algorithms, including 3-D block registration algorithms. Conducted long-range experiments using advanced 3-D sensors for CID applications. Continued passive hyperspectral model development, validation, and performance predictions, and assessed signature-based data processing performance based on ground demonstration data. Continued flights, analysis, and evaluation of multi-function laser radar for identification of ground targets.

(U) In FY 2004: Conduct ground- and air-based testing and demonstration of an advanced Combat Identification (CID) system with multi-spectral detection and cueing, and active electro-optical (EO) target long-range combat identification sensors. Integrate advanced, 3-D focal planes and algorithms in a concept design of a high altitude system to detect targets in relevant environments. Continue passive hyperspectral model development, validation, and performance predictions specifically supporting the flying testbed. Define technologies suited to layered sensing approaches for deep penetration and continuous target area coverage.

(U) In FY 2005: Continue ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based detection and cueing and active EO target long-range combat identification sensors. Complete integration of advanced 3-D focal planes and algorithms in concept design of high altitude system and perform technology demonstrations in relevant configurations. Extend passive hyperspectral model to emissive spectral region and perform validation experiments with flying testbed. Extend passive EO/IR enhancements by incorporating passive polarization techniques into both modeling and performance assessments. Develop electro-optical system architectures for layered sensing based on multiple platform types for deep penetration and continuous target area

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**	

	coverage.			
(U)				
(U)	MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification.	2.076	2.014	2.429
(U)	In FY 2003: Developed pulsed vibration sensing system for long-range combat identification (CID). Initiated developing flight-capable, multi-function architectures. Integrated platform compensation techniques into new architectures. Developed breadboard multi-spectral transmitter, and predicted performance for different types of targets.			
(U)	In FY 2004: Laboratory demonstrate a multi-function, pulsed vibration imaging sensing system for long-range CID. Test and evaluate sensors utilizing 3-D focal planes. Continue developing flight capable multi-function architectures. Continue fabricating a breadboard multi-spectral transmitter and evaluate performance for different types of targets.			
(U)	In FY 2005: Evaluate performance of multi-function pulsed vibration/imaging sensing system for long-range CID. Complete breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Initiate flight capable, long-range, multi-function brassboard sensor development. Tailor flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Perform initial flights for pulsed vibrometer CID sensor.			
(U)				
(U)	MAJOR THRUST: Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions.	4.029	7.510	7.636
(U)	In FY 2003: Continued utility analysis of high altitude active sensors, including platform trades. Performed tower tests of an active multi-spectral imaging system. Demonstrated imaging through weather and obscurants through flight test of active imaging sensors. Designed and demonstrated concepts based on high precision pointing, range gating, and image processing. Developed concepts for airborne application of non-mechanical beam steering devices, including mitigating aero-optical effects. Investigated concepts for combined radio frequency and electro-optical (EO) apertures.			
(U)	In FY 2004: Develop high altitude active sensor performance specifications and concept design. Integrate weather and obscurant penetration concepts. Initiate evaluating non-mechanical beam steering concepts for high altitude sensor applications including precision pointing, focusing, and wavefront correction. Perform an initial demonstration of a combined EO and radio frequency aperture. Perform tests, analyses, and evaluations of a specialized multi-function laser radar for the detection and characterization of difficult targets.			
(U)	In FY 2005: Complete high altitude active sensor performance specification and concept design. Complete the evaluation of and demonstrate non-mechanical beam steering concepts for high altitude sensor application including precision pointing, focusing, and wavefront correction. Continue development and demonstrations of a combined EO/radio frequency (RF) aperture. Continue tests, analysis and evaluation of specialized multifunction laser radar for			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	detection and characterization of difficult targets. Collect simultaneous passive and multifunction active sensing phenomenology data for analysis of difficult target detection. Initiate architecture definition for advanced electro-optics unmanned aerial vehicle (UAV) based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Study integration techniques for combining active and passive EO/infrared for enhanced search, detection, location, and identification.			
(U)				
(U)	MAJOR THRUST: Develop countermeasure technologies for use against infrared (IR) guided missiles and electro-optical threats.	1.947	1.149	0.832
(U)	In FY 2003: Continued to design components and refine techniques to defeat imaging missile seekers. Continued the exploitation of advanced IR missile technology.			
(U)	In FY 2004: Complete an IR scene projector to assess imaging sensor capabilities. Initiate evaluating onboard and offboard techniques to defeat imaging missile seekers. Continue exploiting advanced IR missiles and IR sensor technologies			
(U)	In FY 2005: Develop specifications for countermeasure techniques to defeat first generation imaging missile seekers. Continue the exploitation of advanced infrared missiles and infrared sensor technology for countermeasure technique refinement. Initiate characterization of an imaging missile seeker to establish target-tracking capabilities.			
(U)				
(U)	MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue countermeasures.	0.649	0.997	0.832
(U)	In FY 2003: Laboratory tested temporal and spectral tracking algorithms focused on multi-spectral imaging techniques. Initiated the testing of an advanced laser warning receiver for application in a space environment.			
(U)	In FY 2004: Continue laboratory testing temporal and spectral tracking algorithms focused on multi-color imaging techniques. Continue testing an advanced laser warning receiver for application in a space environment, and expand testing to include airborne applications.			
(U)	In FY 2005: Evaluate advanced multi-color spectral sensor technologies and high spatial resolution imaging for enhanced clutter discrimination techniques for tactical missile warning. Continue developing an advanced laser warning receiver for space and airborne applications. Initiate developing a space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations. Initiate developing a laser warning sensor technologies to address ultra-short and tunable laser threats.			
(U)				
(U)	CONGRESSIONAL ADD: Watchkeeper Ultra-Wideband (UWB) Demonstration.	0.000	3.200	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop ultra-wideband radio frequency technology for an unattended ground sensor for perimeter defense.			
(U)	In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech

(U) Total Cost	11.881	18.680	14.657

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost

(U) Related Activities:
PE 0602500F,
(U) Multi-disciplinary Space Technology.
(U) PE 0603253F, Advanced Sensor Integration.
(U) PE 0602301E, Intelligence System Program.
This project has been coordinated through the
(U) Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors		PROJECT NUMBER AND TITLE: 4916 Electromagnetic Tech

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4916 Electromagnetic Tech	11.906	12.151	9.536	9.876	10.273	10.694	11.134	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technologies for sensor systems that cover the electromagnetic spectrum--from radio frequency (RF) to optical. It develops RF antennas and associated electronics for airborne and space-based surveillance. It also investigates RF scattering phenomenology for applications in ground and air moving target indicators in extremely cluttered environments. The project develops active and passive electro-optical (EO) sensors for use in concert with RF sensors. It develops low-cost active sensors that use reliable high-performance solid state components for target detection and identification and missile threat warning. The project also develops passive multi-dimensional sensors to improve battlefield awareness and identify threats at long-range.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate detecting difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.	2.824	2.269	2.510
(U) In FY 2003: Developed models and experimental techniques for characterizing RF scatter from targets, ground clutter, and foliage.			
(U) In FY 2004: Continue developing models and experimental techniques for the characterization of RF frequency scattering from targets, ground clutter, and foliage.			
(U) In FY 2005: Develop and validate target and clutter models and innovative measurement techniques for the parametric description of radar signal scattering from targets, terrain, and foliage.			
(U)			
(U) MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance.	2.740	2.429	2.552
(U) In FY 2003: Designed, analyzed, and built advanced large, lightweight antenna arrays. Developed new algorithms for digital beam forming and limited-scan phased array antennas. Developed high-speed electronics for antenna front end applications and micro-electro-mechanical systems technology for delayed line switching in phased arrays.			
(U) In FY 2004: Evaluate advanced large, lightweight antenna arrays. Evaluate new algorithms for digital beam forming and limited-scan phased array antennas. Evaluate high-speed electronics antenna front end applications and micro-electro-mechanical systems technology for delayed line switching in phased arrays.			
(U) In FY 2005: Extend the design and analysis of advanced large lightweight array antennas. Initiate fabricating breadboard large lightweight array antennas. Develop new algorithms for multi-beam digital beam forming and limited-scan phased array antennas. Validate high-speed electronics antenna front-end applications and micro-electro-mechanical systems technology for delay line switching in phased arrays.			
(U)			
(U) MAJOR THRUST: Design and develop new EO techniques and components for detecting and identifying concealed	2.572	2.179	2.237

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech

	targets.			
(U)	In FY 2003: Designed and fabricated multi-function sensor arrays and the associated materials and device technologies for optical beam steering. Designed and developed active components and integration techniques for autonomous 3-D ladar-guided munitions and other imaging applications. Developed optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.			
(U)	In FY 2004: Continue designing and fabricating multi-function sensor arrays and the associated materials and device technologies for optical beam steering. Continue designing and developing active components and integration techniques for autonomous 3-D laser radar-guided munitions and other imaging applications. Continue developing optical processing techniques that compensate for optical aberrations in aircraft-generated turbulence.			
(U)	In FY 2005: Evaluate multi-function, multisensor optical arrays and the associated materials and device technologies for optical beam steering. Evaluate active components and integration techniques for autonomous 3-D laser-radar-guided munitions and other imaging applications. Evaluate optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.			
(U)				
(U)	MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates.	2.791	2.274	2.237
(U)	In FY 2003: Established viability of tomographic hyperspectral sensing techniques for aerospace applications. Demonstrated the applicability of tomographic hyperspectral sensor concepts to characterizing explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.			
(U)	In FY 2004: Evaluate the viability of tomographic hyperspectral sensing techniques for aerospace applications. Evaluate the applicability of tomographic hyperspectral sensor concepts to characterizing explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.			
(U)	In FY 2005: Initiate developing technology for a new dual band tomographically based sensor system for characterizing energetic battlefield events in real-time. Develop techniques that use hyperspectral, simultaneous dual-band information to increase the validity of target declaration and to reduce false alarms.			
(U)				
(U)	CONGRESSIONAL ADD: Phased Array Antenna and Control System.	0.979	0.000	0.000
(U)	In FY 2003: Developed a phased array antenna control system by implementing computer algorithms that control the antenna's beam pointing, and by developing the computer hardware necessary to enable system operators to monitor antenna operations and the antenna's health and status.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas.	0.000	3.000	0.000
(U)	In FY 2003: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech

(U) In FY 2004: Develop innovative, low-cost designs and fabrication methods that achieve high performance and proliferation of advanced phased array antennas into new military applications.

(U) In FY 2005: Not Applicable.

(U) Total Cost	11.906	12.151	9.536

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, (U) Multi-disciplinary Space Technology. (U) PE 0602702F, Command Control and Communications. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 5016 Photonic Component Technology	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5016 Photonic Component Technology	3.191	2.889	2.878	2.157	2.187	2.369	2.541	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, photonic component technology work previously performed in this PE, Project 2002, transferred to this project.

(U) A. Mission Description and Budget Item Justification

This project focuses on designing and developing methods to generate, control, receive, transmit, and process opto-electronic (mixed) signals for radio frequency (RF) sensor aerospace applications. Enabling technologies developed under this project for intelligence, surveillance, reconnaissance, electronic warfare (EW), and precision engagement sensors include: low noise, aerospace environmentally-qualified signal control components (e.g., electro-optical (EO) switches, micro-opto-electronic mixed signals; electro-optical components for RF links; photonic signal control, distribution, and signal processing; multi-function, aerospace-qualified, opto-electronic integrated circuits; wideband photonic-based high-speed EO analog-to-digital and digital-to-analog converters; and opto-electronic intraconnects and interconnects. This project designs, develops, fabricates, and evaluates techniques for integrating various combinations of photonic and electronic technologies. The main purpose is to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower prime power, higher reliability, and improved performance -- as compared to current systems. The device, component, and subsystem technology developments under this project are military unique and based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, sensors, communications, EW, navigation, and smart weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop integrated photonic technology components.	2.049	2.148	2.878
(U) In FY 2003: Developed high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband RF phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U) In FY 2004: Evaluate high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U) In FY 2005: Laboratory test and validate high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U)			
(U) MAJOR THRUST: Develop photonic analog-to-digital conversion component technology.	1.142	0.741	0.000
(U) In FY 2003: Developed ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.			
(U) In FY 2004: Evaluate, test, and validate ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5016 Photonic Component Technology**

(U) In FY 2005: Not Applicable. Work completed.

(U) Total Cost	3.191	2.889	2.878

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 5017 RF Processing for ISR Sensors

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5017 RF Processing for ISR Sensors	7.400	6.643	7.362	7.726	7.336	7.599	7.789	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in radio frequency (RF) processing for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 7622, transferred to this project.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses radar technology for affordable, reliable, all weather aerospace ISR systems. Emphasis is on detecting and tracking surface and airborne targets that have difficult to detect signatures due to reduced cross sections, concealment and camouflage measures, severe clutter, or heavy jamming. Techniques exploited include the use of multiple radio frequency (RF) phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop distributed airborne sensor systems to increase sensitivity and improve location accuracy.	1.038	0.498	0.407
(U) In FY 2003: Investigated RF processing techniques for implementing distributed airborne sensor systems to increase sensitivity and improve location accuracy. These techniques include sparse arrays with maneuvering platforms and improved location accuracy using interfermetric methods combined with knowledge-based responsive mode selections.			
(U) In FY 2004: Demonstrate, through computer simulation and emulation, the RF processing techniques for implementing distributed airborne sensing techniques for detecting, locating, and engaging airborne and ground targets.			
(U) In FY 2005: Demonstrate in the laboratory the proof of concept of RF processing techniques for implementing distributed airborne sensing techniques for detecting, locating, and engaging airborne and ground targets.			
(U)			
(U) MAJOR THRUST: Investigate techniques for multi-intelligence data acquisition from a single platform.	1.987	2.312	2.221
(U) In FY 2003: Investigated common waveform techniques, knowledge-based scheduling, and advanced target detection for both unconcealed and concealed targets. Determined the electromagnetic compatibility issues associated with simultaneously hosting and operating multiple radars, electronic support measure receivers, integrated communications, and electronic attack components on a single platform. Investigated methods to mitigate unintentional interference sources to multi-intelligence platforms from the ground and in the air, such as commercial broadcast assets, civilian radar assets, and commercial communications systems.			
(U) In FY 2004: Evaluate multi-function radar sensing through computer simulations and emulations. Evaluate the electromagnetic compatibility issues associated with hosting multiple radars, electronic support measure receivers,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5017 RF Processing for ISR Sensors

integrated communications equipment, and electronic attack components on a single platform capable of operating simultaneously. Continue investigating methods to mitigate unintentional interferers on the ground and in the air such as commercial broadcast assets, civilian radar assets, and commercial communications systems on multi-intelligence platforms. Initiate investigating electronic counter-countermeasure techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.

(U) In FY 2005: Validate multi-function radar sensing through computer simulations and emulations. Laboratory test radio frequency (RF) processing techniques to minimize the electromagnetic compatibility issues associated with hosting multiple radars, electronic support measure receivers, integrated communications equipment, and electronic attack components on a single platform capable of operating simultaneously. Evaluate methods to mitigate unintentional interferers on the ground and in the air such as commercial broadcast assets, civilian radar assets, and commercial communications systems on multi-intelligence platforms. Develop electronic counter-countermeasure techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing. Initiate research in advanced electronic counter countermeasure measures (ECCM) techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.

(U)

(U)	MAJOR THRUST: Develop multi-mission aerospace microwave processing algorithms to detect and locate advanced cruise missiles, slowly moving ground targets, and stationary targets in severe clutter and jamming environments.	2.568	3.052	1.899

(U) In FY 2003: Studied multi-mission adaptive radar algorithms to support various operational modes, including air and ground target detection, ground target imaging, electronic protection, and passive RF emission detection. Studied advanced waveforms for achieving transmitter adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversities in frequencies, delays, polarizations, modulations, and codings. Developed knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication sensors.

(U) In FY 2004: Develop multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operations to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization and modulation, and coding. Evaluate and refine knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication sensors.

(U) In FY 2005: Evaluate multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Continue developing advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, and modulation and

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5017 RF Processing for ISR Sensors

	coding. Laboratory test knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in multi-intelligence sensors.			
(U)				
(U)	MAJOR THRUST: Study and analyze technology for detecting and precisely locating concealed targets using standoff aerospace platforms.	0.530	0.781	2.211
(U)	In FY 2003: Initiated an investigation of emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Initiated the study of adaptive processing techniques for multi-mission conformal arrays. Initiated the study of wideband and polarization adaptive processing techniques for multi-function radar.			
(U)	In FY 2004: Develop emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Study and analyze adaptive processing techniques for multi-mission conformal arrays. Study and analyze wideband and polarization adaptive processing techniques for multi-function radar. Initiate investigating distributed processing technology for next generation, deep-reach target detection and tracking.			
(U)	In FY 2005: Evaluate emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Develop adaptive processing techniques for multi-mission conformal arrays. Develop and evaluate wideband and polarization adaptive processing techniques for multi-function radar. Continue investigating distributed processing technology for next generation deep-reach target detection and tracking.			
(U)				
(U)	MAJOR THRUST: Develop wideband integrated photonic components.	0.000	0.000	0.353
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Initiate developing high-performance, low loss, wideband integrated photonic link, interconnect, and switching components and subsystems for all weather space and airborne surveillance and reconnaissance systems. This work is an outgrowth of other work in this project.			
(U)				
(U)	MAJOR THRUST: Develop wideband photonic analog-to-digital mixed signal conversion component technologies.	0.000	0.000	0.271
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Initiate developing high-resolution, ultra-fast, multi-gigahertz wideband photonic analog-to-digital mixed signal conversion component technology for all weather space and airborne surveillance and reconnaissance systems. This work is an outgrowth of other work in this project.			
(U)				
(U)	CONGRESSIONAL ADD: AFRL Information and Sensors Directorate.	1.277	0.000	0.000
(U)	In FY 2003: Tested and evaluated Global Positioning System receivers to assess potential problems from spectrum encroachment by ultra-wideband devices.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5017 RF Processing for ISR Sensors

(U) In FY 2004: Not Applicable.
(U) In FY 2005: Not Applicable.

(U) Total Cost	7.400	6.643	7.362

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, (U) Multi-disciplinary Space Technology. (U) PE 0603203F, Advanced Aerospace Sensors. (U) PE 0603270F, Electronic Combat Technology. (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 6095 Sensor Fusion Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
6095 Sensor Fusion Technology	12.670	12.131	13.246	15.626	16.267	16.781	17.146	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project transferred to PE 0602500F, Project 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops the technologies required to perform management and fusion of sensor information for timely, comprehensive situational awareness, automatic target recognition (ATR), integrated fire control, and bomb damage assessment. This project determines the feasibility of technologies and concepts for fire control that help to precisely locate, identify, and target airborne and surface targets. The project emphasizes finding reduced signature targets and targets of opportunity. It will enable new covert tactics for successful air-to-air and air-to-surface strikes.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets.	3.789	3.709	1.614

(U) In FY 2003: Continued integrating and demonstrating single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Continued integrating real-time ATR algorithms, for time-critical targets, on embedded high-performance computing systems. Completed laboratory demonstration of adaptive resource allocation methods. Continued integrating and evaluating algorithms and concepts for detecting and targeting targets under trees (TUT). Completed developing single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Continued ATR performance evaluation theory research. Completed the first single sensor ATR performance prediction model.

(U) In FY 2004: Evaluate single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Validate integrating real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Laboratory test algorithms and concepts for detecting and targeting targets under trees. Evaluate single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Continue ATR performance evaluation theory research. Evaluate the first single sensor ATR performance prediction model.

(U) In FY 2005: Develop improvement in image formation and processing of Synthetic Aperture Radar (SAR) data from Research & Development (R&D) data collections. Develop automated image analysis and truthing tools. Employ synthetic data generation tools to augment and enhance existing R&D and operational data sets. Improve ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Assess the effectiveness of real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Laboratory test multi-sensor and sensor fusion assessment algorithms. Continue ATR performance

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

	evaluation theory research. Laboratory test the first multi-sensor ATR performance prediction model.			
(U)				
(U)	MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support automatic target recognition (ATR) and sensor fusion algorithm development and testing for reconnaissance and strike mission applications.	3.798	3.891	6.429
(U)	In FY 2003: Developed target signature models for signature exploitation of synthetic aperture radar, electro-optical (EO) multi-spectral systems, and signals intelligence sensors. Demonstrated the ability to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Developed modeling and simulation tools that can estimate warfighter effectiveness enhancements due to inserting ATR and sensor fusion aids into the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)	In FY 2004: Laboratory test target signature models for signature exploitation of radio frequency (RF) sensors, electro-optical multispectral systems, and signals intelligence sensors. Generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Develop synthetic scene data generation capability to augment and enhance existing research and development and operational data sets. Evaluate modeling and simulation tools for estimating warfighter effectiveness enhancements enabled by inserting ATR and sensor fusion aids to the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)	In FY 2005: Evaluate target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Evaluate preliminary two-class ATR for EO sensed vibration of tactical ground targets. Continue developing a synthetic scene data generation capability applicable to large area reconnaissance coverage. Upgrade fidelity of modeling and simulation tools that estimate warfighter effectiveness enhancements enabled by inserting ATR and sensor fusion aids to the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate enabling ATR, sensor management, and sensor fusion technologies for target detection, tracking, and identification in intelligence, surveillance, and reconnaissance (ISR) and combat identification (CID) applications.	4.321	4.531	5.203
(U)	In FY 2003: Completed evaluating adaptive learning techniques for target identification. Initiated laboratory demonstration of adaptive sensor management algorithms for target detection, tracking, and identification. Continued evaluating physics-based techniques for target detection and identification for ISR and CID applications.			
(U)	In FY 2004: Exploit adaptive learning techniques for target identification using three-dimensional sensors. Study exploitable radar features for target detection, tracking, and identification. Laboratory test physics-based techniques for target detection and identification for ISR and CID applications. Initiate laboratory demonstration of advanced			

algorithms for detection and identification of targets under trees in the presence of heavy camouflage, concealment, and deception.

(U) In FY 2005: Develop exploitable radar features for target detection, tracking, and identification. Continue laboratory demonstration of advanced algorithms for detection and identification of targets under trees and/or in the presence of heavy camouflage, concealment, and deception. Initiate technology development that will capitalize on precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing. Develop capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy.

(U)

(U) MAJOR THRUST: Develop precision time, position, and velocity sensors capable of operating in jamming environments.	0.762	0.000	0.000
(U) In FY 2003: Completed developing Global Positioning System-specific jamming mitigation techniques for operation in hostile radio frequency environments, with an emphasis on synergistically integrating anti-jam technologies. Developed virtual flight test technology for improved assessment of reference sensors.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U) Total Cost	12.670	12.131	13.246

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.									
(U) PE 0603762E, Sensor and									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

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

Guidance Technology. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
7622 RF Sensors & Countermeasures Tech	10.168	16.785	16.053	25.784	25.258	23.269	23.821	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in radio frequency (RF) processing for intelligence, surveillance, and reconnaissance (ISR) sensors transferred from this project to this PE, Project 5017. Also in FY 2003, space unique tasks in this project transferred to PE 0602500F, Project 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses RF sensing concepts for aerospace applications through modeling and simulation. This project also develops and evaluates technology for fire control radar, electronic combat (EC), and integrated radar and EC systems. It emphasizes the detecting and tracking of surface and airborne targets with RF signatures that are difficult to detect due to reduced radar cross sections, concealment and camouflage measures, severe clutter, or heavy jamming. This project also develops the RF warning and countermeasure technology for advanced EC applications. Specifically, it develops techniques and technologies to detect and counter the links and sensors of threat air defense systems and hostile command and control networks. The project also exploits emerging technologies and components to provide increased capability for offensive and defensive RF sensors, including radar warning, RF EC, and electronic intelligence applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop affordable RF jamming technology and concepts that enhance aerospace vehicle survivability by degrading enemy radar, missile, and command and control systems.	4.583	5.036	4.086
(U) In FY 2003: Developed multi-function EW technique waveforms. Continued exploitation evaluations against new, advanced RF threats. Developed optimized EW techniques to degrade modern radar, communications, and missile threat systems. Initiated phase calibration development.			
(U) In FY 2004: Evaluate multi-function electronic warfare (EW) technique waveforms. Continue exploitation evaluations against new, advanced RF threats. Continue developing optimized EW techniques to degrade modern radar, communications, and missile threat systems. Perform laboratory demonstration of a phase calibration system for a monopulse countermeasure technique to protect all Air Force platforms.			
(U) In FY 2005: Develop a complex signal communication environment simulator that contains both adversary and friendly advanced spread spectrum signals. Develop technology for an advanced digital communications jammer. Continue exploitation evaluations against new, advanced RF threats. Evaluate results of a laboratory demonstration of phase calibration system for a monopulse countermeasure technique to protect all Air Force platforms.			
(U)			
(U) MAJOR THRUST: Develop technology to enable affordable upgrades to RF signal receivers.	1.649	2.064	1.268
(U) In FY 2003: Modeled threat identification algorithms for next generation threat warning receivers. Evaluated state-of-the-art radar and EW digital receiver subsystems with Gallium Arsenide and Indium Phosphide RF			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech

components (analog-to-digital converters, filters, mixers, etc.) for laboratory environment scenario testing. Designed advanced very high frequency receiver improvements for detecting targets under trees.

(U) In FY 2004: Develop threat identification algorithms for next generation threat warning receivers. Continue designing advanced very high frequency receiver improvements for detecting targets under trees. Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, radio frequency (RF), microwave, etc.) component development in advanced and emerging technologies. Demonstrate breadboard electronic/photonic wideband digital receiver for multi-mode/multi-function applications.

(U) In FY 2005: Validate threat identification algorithms for next generation threat warning receivers. Develop affordable RF wideband RF cueing receiver technology. Evaluate the impact of mixed-signal (digital, RF, microwave, etc.) and mixed-technology (electronics, micro-electro-mechanical, photonics, etc.) component development using advanced and emerging technologies for digital receiver and exciter systems.

(U)

(U) MAJOR THRUST: Develop robust, ultra-widebandwidth antenna technology for use in operational and future aerospace platform electronic apertures.	1.215	0.918	2.090

(U) In FY 2003: Demonstrated breadboard wideband, high precision interferometric multi-mode direction finding antennas. Developed design tools to predict antenna performance installed on host platform models. Demonstrated components and techniques that increase five-fold the signal handling capability of an aperture.

(U) In FY 2004: Evaluate breadboard wideband, high-precision interferometric multi-mode direction finding antennas. Continue developing design tools to predict antenna performance installed on host platform models. Develop techniques that provide low-cost, lightweight phased arrays for low band applications.

(U) In FY 2005: Develop and laboratory demonstrate advanced wideband (3:1) transmit/receive (T/R) channel technology. Evaluate design tools to predict antenna performance installed on host platform models. Laboratory demonstrate techniques that provide low-cost, lightweight phased arrays for low band applications.

(U)

(U) MAJOR THRUST: Develop multi-function RF sensing concepts.	2.721	6.560	4.685

(U) In FY 2003: Developed and evaluated innovative multi-function RF sensing concepts for aerospace applications through modeling and simulation with an emphasis on system engineering.

(U) In FY 2004: Develop and evaluate advanced multi-function and multi-intelligence RF sensors for intelligence, surveillance, and reconnaissance and targeting of time-critical targets. Develop testbed integration techniques for advanced multi-intelligence sensor hardware and algorithms. Develop and evaluate multi-platform sensor coordination and synchronization techniques.

(U) In FY 2005: Model and simulate innovative multi-function RF sensing concepts for air and space applications. Develop and evaluate advanced multi-function and multi-intelligence RF sensors for intelligence, surveillance, and reconnaissance and targeting of time-critical targets with applications in unmanned aerial vehicles and manned

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech

aircraft. Initiate testbed planning and experiment design to support validation of concepts and the subsystem requirements for advanced multi-intelligence sensors.

(U)

(U) MAJOR THRUST: Develop digital radio frequency (RF) receiver/exciter technology to support digital beamforming. 0.000 2.207 2.054

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Analyze and develop approaches to address digital beamforming- (DBF) specific issues such as such as coherence of multiple channels, digital true time delay, channel equalization, distributed waveform generation, and array calibration. Develop techniques for integrating multi-intelligence radio frequency receiver/exciter subsystems into aperture and signal processing testbeds.

(U) In FY 2005: Develop and evaluate DBF-specific receiver/exciter technologies that stress reduced size, weight, and power consumption, affordability using advanced digital technologies, RF packaging, and functional integration of the RF receiver, analog-to-digital conversion, digital channelization, and digital time delay beamsteering subsystems. Perform testbed integration of multi-intelligence RF receiver/exciter, aperture, and signal processing subsystems.

(U)

(U) MAJOR THRUST: Design exploratory outdoor time transfer experiments between multiple moving platforms for enhanced situational awareness. 0.000 0.000 1.196

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Develop experiments in assured reference to evaluate advanced navigation technologies for network centric warfare applications.

(U)

(U) MAJOR THRUST: Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, and modulation and coding. 0.000 0.000 0.674

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Develop adaptive processing techniques for multi-mission conformal arrays.

(U) Total Cost 10.168 16.785 16.053

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0602500F,

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech

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

(U) Multi-disciplinary Space Technology.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603253F, Advanced Avionics Integration.

(U) PE 0602782A, Command, Control, Communications Technology.

(U) PE 0602232N, Navy C3 Technology.

(U) PE 0603792N, Advanced Technology Transition.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.