PE NUMBER: 0602204F
PE TITLE: Aerospace Sensors

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	86.093	93.376	93.263	94.486	93.221	97.535	98.249	99.488	Continuing	TBD
2002	Electronic Component Technology	18.416	18.905	21.284	23.614	23.364	24.154	23.675	23.127	Continuing	TBD
2003	EO Sensors & Countermeasures Tech	17.961	18.097	14.377	14.734	15.049	15.943	16.125	16.302	Continuing	TBD
4916	Electromagnetic Tech	12.151	17.182	10.632	11.090	11.576	12.228	12.758	13.364	Continuing	TBD
5016	Photonic Component Technology	2.830	2.852	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5017	RF Processing for ISR Sensors	6.221	7.297	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
6095	Sensor Fusion Technology	12.013	13.129	16.308	15.600	15.693	16.107	16.321	16.533	Continuing	TBD
7622	RF Sensors & Countermeasures Tech	16.501	15.914	30.662	29.448	27.539	29.103	29.370	30.162	Continuing	TBD

Note: In FY 2006, efforts in Project 5016 will transfer to Project 2002 within this PE. Also in FY 2006, efforts in Project 5017 will transfer to Project 7622 within this PE.

(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 (EO) 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 RF sensors and electronic combat systems. Note: In FY 2005, Congress added $2.0 million for 3-D Packaging Technology for High Speed RF Communication, $1.3 million for Phased Array Antenna Control Computer, $1.6 million for Watchkeeper UWB [Ultra-Wideband] Demonstration, $3.0M for the Center for Advanced Sensor and Communications Antennas, $2.0 million for General Purpose Reconfiguration Signal Processors System, $1.0 million for Optical Signature Recognition System for Authenticity Verification, $2.0 million for Super-resolution Sensor System, $4.9 million for Minority LEADERS (transferred to PE 0601102F), $1.0 million for Compact Optical Receiver for Smart and Loitering Weapons, and $1.5 million for Stable Articulating Backbone for Ultralight Radar Project (transferred from PE 0602500F for execution in this PE). 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 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors

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

	FY 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	86.405	78.804	93.839	96.715
(U) Current PBR/President's Budget	86.093	93.376	93.263	94.486
(U) Total Adjustments	-0.312	14.572		
(U) Congressional Program Reductions				
Congressional Rescissions		-0.828		
Congressional Increases		15.400		
Reprogrammings				
SBIR/STTR Transfer	-0.312			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 2002 Electronic Component Technology

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2002 Electronic Component Technology	18.416	18.905	21.284	23.614	23.364	24.154	23.675	23.127	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006 efforts in Project 5016 will transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for RF sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance (ISR), electronic warfare (EW), battlespace access, and precision engagement capabilities. The technologies developed include: exploratory device concepts, solid state power devices and amplifiers; low noise and signal control components; photonic 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; reconfigurable electronics; 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System, radar, EW, and ISR sensors. Develop advanced aperture subsystems that support affordable and scalable antenna arrays, as well as enable efficient wideband, multi-function sensors for radar, EW, and communications. Develop receiver and exciter subsystem technologies that enable compact, affordable, multi-function, multi-beam radar and EW systems.	2.889	5.050	6.635	7.602

(U) In FY 2004: Developed 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. Evaluated 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 DBF-specific GaAs RF components (ADCs, filters, mixers, etc.) with the technology upgrade plan for InP RF components into radar and EW digital receiver modules.

(U) In FY 2006: Demonstrate low cost, lightweight subpanel for phased array radar applications.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 2002 Electronic Component Technology	

	Demonstrate an affordable, compact Receiver on a Chip by leveraging advances in commercial silicon germanium technology for multifunction and reconfigurable sensor systems.				
(U)	In FY 2007: Develop scalable panel demonstration with multiple panel communication and metrology. Design and demonstrate a distributed receiver/exciter architecture for advanced multifunction systems used in radar and EW sensors for ISR and battlespace access capabilities.				
(U)					
(U)	MAJOR THRUST: Develop microwave, millimeter wave, and optical components using state-of-the-art microelectronics fabrication technology for advanced RF apertures and phased array antennas used in military ISR and precision strike applications.	2.548	0.815	0.962	1.660
(U)	In FY 2004: Developed and demonstrated 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)	In FY 2006: Develop engineering model of advanced photonic modulation components for low loss signal distribution.				
(U)	In FY 2007: Demonstrate integrated photonic microsystems.				
(U)					
(U)	MAJOR THRUST: Develop integration and assembly technologies for high performance aerospace phased array sensors. Design and model photonic component technologies for RF distribution and signal processing.	2.261	1.900	2.132	3.337
(U)	In FY 2004: Developed and demonstrated 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)	In FY 2006: Design and fabricate advanced components for external and direct modulation of optical sources with high efficiency for RF photonic links used in radar and communications.				
(U)	In FY 2007: Demonstrate optical modulation technology with high linearity and dynamic range for ISR, battlespace access, and time-sensitive targeting capabilities.				
(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, and ISR sensors. Develop and integrate adaptable circuit technologies which utilize dynamic elements and low loss signal control for multi-function radar and EW sensors used for ISR and battlespace access capabilities.	3.035	4.427	6.752	7.113

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 2002 Electronic Component Technology	

	Develop wideband (multi-octave) component technologies for multi-function RF apertures used in radar and EW sensor systems.				
(U)	In FY 2004: Fabricated 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)	In FY 2006: Design, implement and characterize low insertion loss tunable filters for advanced RF multifunction front ends. Demonstrate RF transistors with five-fold reduction in parasitic capacitance for equivalent power output. Design and demonstrate Gallium Nitride (GaN) based field-effect devices with enhanced power handling capabilities.				
(U)	In FY 2007: Develop and demonstrate adaptable microcircuits for multi-function applications. Characterize and transition reliable wideband power amplifiers for multifunction radar and EW sensor applications. Characterize high reliability GaN based circuits for millimeter wave and Q-band applications.				
(U)					
(U)	MAJOR THRUST: Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment. Develop and demonstrate innovative RF component technology that lowers system cost through reduction of design costs, part count, chip size, production costs, and integration costs.	1.441	1.085	0.960	0.582
(U)	In FY 2004: Developed and demonstrated mixed-signal receiver/processor multi-functionality on flexible arrays using advanced two-dimensional and three-dimensional interconnects, and package-less protection schemes. Verified the electrical performance of these mixed-signal assemblies and validated 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)	In FY 2006: Develop advanced component characterization techniques to assess and mitigate failures in emerging semiconductor technologies and to develop predictive failure models.				
(U)	In FY 2007: Design and implement military specific RF components using advanced circuit compaction techniques and latest commercial foundry advances. Characterize and perform trade-space analysis with respect to traditional RF component technologies.				
(U)					
(U)	MAJOR THRUST: Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, RF, microwave, etc.) component development in both advanced and emerging electronic component technologies.	0.990	1.628	3.843	3.320

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

(U)	In FY 2004: Laboratory tested 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). 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)	In FY 2006: Model and transition electrostatic adaptable microsystems for dense signal environments.				
(U)	In FY 2007: Design and initial modeling of next generation wideband gap devices for high power, high temperature, and broadband multi-function systems.				
(U)					
(U)	CONGRESSIONAL ADD: 3-D Packaging Technology for High Speed Radio Frequency Communication.	2.326	2.000	0.000	0.000
(U)	In FY 2004: Designed, fabricated, and demonstrated proof-of-principle experimental 3-D microcircuit packages for high speed electrical and high-power thermal military sensor applications.				
(U)	In FY 2005: Fabricate, demonstrate and evaluate additional experimental designs for 3-D radio frequency sensing microcircuits for military communication, radar and electronic warfare sensor applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: General Purpose Reconfiguration Signal Processors System.	2.926	2.000	0.000	0.000
(U)	In FY 2004: Accelerated the development and transition of new on-board sensor signal processors for time-critical intelligence, surveillance, reconnaissance (ISR) applications in unmanned aerial vehicles.				
(U)	In FY 2005: Fully characterize the miniature on-board signal processor feasibility unit. Develop an ISR application specific miniature signal processor to meet form, fit, and function requirements.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	Total Cost	18.416	18.905	21.284	23.614

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2002 Electronic Component Technology

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 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.
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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2003 EO Sensors & Countermeasures Tech	17.961	18.097	14.377	14.734	15.049	15.943	16.125	16.302	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop technology for non-cooperative identification of airborne and ground-based platforms.	3.633	2.896	1.732	1.962

(U) In FY 2004: Conducted ground- and air-based testing and demonstration of an advanced Combat Identification (CID) system with multi-spectral detection and cueing, and active EO target long-range combat identification sensors. Integrated advanced, 3-D focal planes and algorithms in a concept design of a high altitude system to detect targets in relevant environments. Developed passive hyperspectral model and validated performance predictions specifically supporting the flying testbed. Defined 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 EO system architectures for layered sensing based on multiple platform types for deep penetration and continuous target area coverage.

(U) In FY 2006: Expand ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based detection and cueing and active EO combat identification sensors to include 3-D imaging. Begin development of hybrid focal planes and read-out electronics capable of

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech

simultaneous multi-discriminant sensing. Complete EO/IR system architectures for layered sensing based on multiple platform types for deep penetration and continuous area coverage.

(U) In FY 2007: Perform off-board cued ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based target re-acquisition and active EO interrogation for combat identification including 3-D imaging and vibration sensing. Continue development of hybrid focal planes and read-out electronics capable of simultaneous multi-discriminant sensing. Begin demonstration of EO/IR system architectures for layered sensing based on multiple platform types for deep penetration and continuous area coverage.

(U)

(U)	MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification.	1.920	2.402	2.406	5.342

(U) In FY 2004: Laboratory demonstrated a multi-function, pulsed vibration imaging sensing system for long-range CID. Tested and evaluated sensors utilizing 3-D focal planes. Developed flight capable multi-function architectures. Fabricated a breadboard multi-spectral transmitter and evaluated 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) In FY 2006: Begin testing of optical transmitter technologies capable of sensing multiple target characteristics for robust non-cooperative target identification. Begin development of adaptable waveforms for multi-discriminant sensing. Begin laboratory and field tests and utility analysis of multi-function pulsed vibration/imaging sensing system and evaluate performance for long range CID. Perform initial flights for pulsed gated imager and vibration CID sensor. Test breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Continue flight capable, long-range, multi-function brassboard sensor development. Utilize flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Collect simultaneous passive and multi-function active sensing phenomenology data in airborne environment for difficult target detection analysis including diverse background characterization.

(U) In FY 2007: Continue development and testing of optical transmitter technologies including waveforms capable of sensing multiple target characteristics for robust non-cooperative target identification. Continue laboratory and field tests and utility analysis of multi-function pulsed vibration/imaging sensing system and evaluate performance for long-range CID. Perform flight data collections for pulsed gated

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech

imager and vibration CID sensor. Complete testing of breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Continue flight capable, long-range, multi-function engineering model sensor development. Utilize flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Continue collection of simultaneous passive and multifunction active sensing phenomenology data in airborne environment for difficult target detection analysis including diverse background characterization.

(U)

(U)	MAJOR THRUST: Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions.	7.161	7.553	6.109	3.734

(U) In FY 2004: Developed high altitude active sensor performance specifications and concept design. Integrated weather and obscurant penetration concepts. Evaluated non-mechanical beam steering concepts for high altitude sensor applications including precision pointing, focusing, and wavefront correction. Performed an initial demonstration of a combined EO and RF aperture. Performed tests, analyses, and evaluations of a specialized multi-function laser radar (LADAR) 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 demonstration of 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/RF aperture. Continue tests, analysis and evaluation of specialized multi-function LADAR for detection and characterization of difficult targets. Collect simultaneous passive and multi-function active sensing phenomenology data for analysis of difficult target detection. Initiate architecture definition for advanced EO unmanned aerial vehicle 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/IR for enhanced search, detection, location, and identification.

(U) In FY 2006: Begin development of techniques and components to target difficult objects in degraded atmospheric conditions. Integrate and evaluate weather/obscurant penetration concepts. Evaluate utility of non-mechanical beam steering concepts for advanced multi-mode sensor applications including precision pointing, focusing, and wavefront correction and extend to common EO/RF aperture implementation. Continue development and demonstrations of combined EO/RF aperture including preliminary sensor configuration. Continue tests, analysis, and evaluation of specialized multi-function LADAR for detection and characterization of difficult targets. Complete optimized architecture definition for advanced EO UAV based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Incorporate advanced passive and multi-function active

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	sensing methods to exploit all salient target and background phenomenologies. Perform target phenomenology investigations.				
(U)	In FY 2007: Continue development and begin demonstration of techniques and components to target difficult objects in degraded atmospheric conditions. Integrate and evaluate weather/obscurant penetration concepts into system level tests. Demonstrate utility of non-mechanical beam steering for advanced multi-mode sensor applications, including precision pointing, focusing, and wavefront correction. Continue development and demonstrations of combined EO/RF apertures including preliminary sensor configuration. Continue analysis and evaluation of specialized multi-function 3-D LADAR for detection and characterization of difficult targets. Explore implementation of advanced architectures for advanced EO UAV-based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Incorporate advanced passive and multifunction active sensing methods to exploit all salient target and background phenomenologies. Continue target phenomenology investigations.				
(U)					
(U)	MAJOR THRUST: Develop countermeasure technologies for use against IR- and EO-guided missile threats.	1.096	0.823	2.426	2.088
(U)	In FY 2004: Completed an IR scene projector to assess imaging sensor capabilities. Evaluated onboard and offboard techniques to defeat imaging missile seekers. Exploited 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 IR missiles and IR sensor technology for countermeasure technique refinement. Initiate characterization of an IR imaging missile seeker to establish target-tracking capabilities.				
(U)	In FY 2006: Evaluate countermeasure techniques to defeat first generation IR imaging missile seekers. Continue the exploitation of advanced IR missiles and IR sensor technology for countermeasure technique updates and refinement. Initiate development of active sensing technology to defeat multi-band IR sensors.				
(U)	In FY 2007: Continue evaluation of countermeasure techniques to defeat first generation IR imaging missile seekers. Initiate development of second generation IR imaging missile seeker models/simulations for countermeasure technique development. Continue exploitation of advanced IR missiles and IR acquisition sensors for countermeasure technique updates and refinement. Conduct laboratory assessments of active sensing technology to evaluate capabilities against multi-band IR sensors.				
(U)					
(U)	MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue	0.951	0.823	1.704	1.608

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

countermeasures.

(U) In FY 2004: Laboratory tested temporal and spectral tracking algorithms focused on multi-color imaging techniques. Tested an advanced laser warning receiver for application in a space environment and expanded 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 airborne pod applications. Initiate development of a space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations. Initiate development of a new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate new laser warning sensor concepts for integration into UAVs and night vision goggles (NVGs).

(U) In FY 2006: Complete developing a laser threat scenario testbed for sensor technology evaluations. Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate development of advanced laser warning concepts for aircraft, to include integration into UAVs and NVGs.

(U) (U) In FY 2007: Laser warning sensor concepts for UAVs and NVGs. Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate development of an advanced laser warning concept for integration into tactical aircraft.

(U)

(U) CONGRESSIONAL ADD: Watchkeeper Ultra-Wideband (UWB) Demonstration.	3.200	1.600	0.000	0.000

(U) In FY 2004: Developed UWB RF technology for an unattended ground sensor for perimeter defense.

(U) In FY 2005: Demonstrate UWB RF technology for an unattended ground sensor for perimeter defense.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Super-resolution Sensor System	0.000	2.000	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Develop and test a high-bandwidth transceiver for laser radar through the utilization of many modulated channels and wavelength division.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	17.961	18.097	14.377	14.734

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:
PE 0602500F,
(U) Multi-Disciplinary Space Technology.
PE 0603253F, Advanced
(U) Sensor Integration.
PE 0602301E, Intelligence
(U) 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 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 4916 Electromagnetic Tech

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4916	Electromagnetic Tech	12.151	17.182	10.632	11.090	11.576	12.228	12.758	13.364	Continuing	TBD
	Quantity of RDT&E Articles	0	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 (EM) spectrum--from RF to EO. 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 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 mutli-dimensional sensors to improve battlefield awareness and identify threats at long-range.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Investigate detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.	2.269	2.469	2.658	2.824
(U) In FY 2004: Developed 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) In FY 2006: Develop integration techniques for combining EM target and clutter physics models with signal processing for improved target detection.				
(U) In FY 2007: Develop integration techniques for multiple platforms, combining EM target and clutter physics models with signal processing for improved target detection.				
(U)				
(U) MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance.	2.429	2.511	2.830	3.008
(U) In FY 2004: Evaluated advanced large, lightweight antenna arrays. Evaluated new algorithms for digital beam forming and limited-scan phased array antennas. Evaluated 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) In FY 2006: Develop and demonstrate novel RF and digital hardware architectures and embedded algorithms that achieve wideband digital beamforming for multi-function phased arrays. Analyze and develop advanced 3-D micro-electro-mechanical RF structures that improve RF circuit design flexibility				

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech	

	and reduce the size and cost of microwave integrated circuits. Investigate and develop novel designs for rugged, wideband, low-profile conformal antennas for airborne applications.				
(U)	In FY 2007: Develop nonlinear embedded algorithms that enhance dynamic range and bandwidth of digital beamforming hardware, enabling the use of lower cost hardware. Demonstrate the integration of microwave integrated circuits into low-cost 3-D micro-electro-mechanical RF structures designed for a miniature seeker radar. Analyze and develop digital beamforming architectures for conformal phased array antennas for future air-to-air radar system applications.				
(U)					
(U)	MAJOR THRUST: Design and develop new EO techniques and components for detecting and identifying concealed targets.	2.179	2.201	2.314	2.250
(U)	In FY 2004: 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 laser radar (LADAR) guided munitions and other imaging applications. Developed optical processing techniques that compensate for optical aberrations in aircraft-generated turbulence.				
(U)	In FY 2005: Evaluate multi-function, multi-sensor optical arrays and the associated materials and device technologies for optical beam steering. Evaluate active components and integration techniques for autonomous 3-D LADAR-guided munitions and other imaging applications. Evaluate optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.				
(U)	In FY 2006: Test newly developed avalanche photo diodes (APD) integrated with electronic readout circuits. Integrate subcomponents with flash LADAR system and perform live tests to evaluate guidance and range resolution capability. Test and evaluate next generation APD designs and incorporate in 3-D LADAR test-bed. Continue development of quasi-phased matched materials for laser wavelength conversion applications.				
(U)	In FY 2007: Develop Zinc Oxide (ZnO), Aluminum Nitride (AlN) and Gallium Nitride (GaN) semiconductors for high power, high temperature EO applications. Develop single crystal GaN substrates for use in detection of biological agents in clouds and in harsh battlefield environments. Use developed LADAR techniques to extend range of agent and target detection. Develop ZnO, GaN, and AlN-based APDs for increased range and detection sensitivity and for non-line-of-sight covert communications.				
(U)					
(U)	MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates.	2.274	2.201	2.830	3.008
(U)	In FY 2004: Evaluated the viability of tomographic hyperspectral sensing techniques for aerospace applications. Evaluated the applicability of tomographic hyperspectral sensor concepts to characterizing				

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech	

	explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.				
(U)	In FY 2005: Develop 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)	In FY 2006: Design dual band tomographically based sensor system utilizing Cross Dispersion Prism (CDP) to characterize energetic battlefield events in real-time. Create CDP prototype and begin in-house calibration and performance evaluation. Refine CDP techniques used to validate target declaration and reduce false alarms. Design and develop micro-lens multi-spectral sensor for real-time threat warning and battle damage assessment.				
(U)	In FY 2007: Continue evaluation of CDP-based sensor system performance. Expand evaluation of CDP-based sensor system to field testing of various assets of interest and integration of CDP for target validation and reduction of false alarms. Continue design and development of micro-lens multi-spectral sensor for real-time threat warning and battle damage assessment. Evaluate micro-lens multi-spectral sensor performance for real-time threat warning and battle damage assessment.				
(U)					
(U)	CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas.	3.000	3.000	0.000	0.000
(U)	In FY 2004: Developed 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: Extend the development of innovative, low-cost designs and fabrication methods to achieve high performance and proliferation of advanced phased array antennas into new military applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Phased Array Antenna and Control System.	0.000	1.300	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop control system for a 12-meter diameter dome phased array antenna. Develop beam resource management of multiple simultaneous active receive and transmit apertures on the dome surface. Develop tracking algorithms for large apertures including various approaches to track the fluctuating signals from unstable beams. Develop techniques for remote dome management allowing a remote control center to configure beams and allocate them to individual users. Develop approaches for handling dome health and status information so maintenance requirements can be collected at a remote central site.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 4916 Electromagnetic Tech

(U)					
(U)	CONGRESSIONAL ADD: Optical Signature Recognition Signal Processor System.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop a unique optical signature recognition system for authenticity verification of Department of Defense identification cards and other documents.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Compact Optical Receiver for Smart and Loitering Standoff Weapons.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop a small footprint, ultra-sensitive, eye-safe optical receiver.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Stable Articulating Backbone for Ultralight Radar (SABUR) Project.	0.000	1.500	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop the mechanical deployment structure for SABUR. Design the radar truss and the metrology and signal processing needed to maintain coherence and pointing accuracy. Build large-scale working prototypes of the concept.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	12.151	17.182	10.632	11.090

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602500F, Multi-Disciplinary Space Technology. PE 0602702F, Command Control and Communications. This project has been coordinated through the Reliance process to										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech

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

harmonize efforts and
eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 5016 Photonic Component Technology

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5016 Photonic Component Technology	2.830	2.852	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this project will transfer to Project 2002 within this PE.

(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 RF sensor aerospace applications. Enabling technologies developed under this project for ISR EW and precision engagement sensors include: low noise, aerospace environmentally-qualified signal control components (e.g., EO switches, micro-opto-electronic mixed signals); EO components for RF links; photonic signal control, distribution, and signal processing; multi-function, aerospace-qualified, 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop integrated photonic technology components.	2.104	2.852	0.000	0.000
(U) In FY 2004: Evaluated 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 2005: Laboratory test and validate 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 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop photonic analog-to-digital conversion component technology. Note: Efforts completed in FY 2004.	0.726	0.000	0.000	0.000
(U) In FY 2004: Evaluated, tested, and validated ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U) Total Cost	2.830	2.852	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5016 Photonic Component Technology

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:
PE 0602500F,
(U) Multi-Disciplinary Space Technology.
PE 0603203F, Advanced
(U) Aerospace Sensors.
PE 0603270F, Electronic
(U) Combat 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5017	RF Processing for ISR Sensors	6.221	7.297	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this project will transfer to Project 7622 within this PE.

(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 RF phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop distributed airborne sensor systems to increase sensitivity and improve location accuracy.	0.466	0.403	0.000	0.000
(U) In FY 2004: Demonstrated, 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Investigate techniques for multi-intelligence data acquisition from a single platform.	2.166	2.201	0.000	0.000
(U) In FY 2004: Evaluated multi-function radar sensing through computer simulations and emulations. Evaluated the EM 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. Investigated 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. Initiated 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 RF processing techniques to minimize the EM compatibility issues associated with hosting multiple radars, electronic support measure receivers, integrated communications equipment, and				

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 5017 RF Processing for ISR Sensors	

	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 (ECCM) techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing. Initiate research in advanced ECCM techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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.	2.858	1.882	0.000	0.000
(U)	In FY 2004: Developed multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Developed 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. Evaluated and refined 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 coding. Laboratory test knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in multi-intelligence sensors.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Study and analyze technology for detecting and precisely locating concealed targets using stand off aerospace platforms.	0.731	2.191	0.000	0.000
(U)	In FY 2004: Developed emerging adaptive processing techniques for knowledge-aided, multi-mission processing and resource management. Studied and analyzed adaptive processing techniques for				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5017 RF Processing for ISR Sensors

multi-mission conformal arrays. Studied and analyzed wideband and polarization adaptive processing techniques for multi-function radar. Initiated 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) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)	MAJOR THRUST: Develop wideband integrated photonic components.	0.000	0.350	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Initiate the development of 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) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)	MAJOR THRUST: Develop wideband photonic analog-to-digital mixed signal conversion component technologies.	0.000	0.270	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Initiate the development of 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) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	6.221	7.297	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602500F, Multi-Disciplinary Space										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 5017 RF Processing for ISR Sensors

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

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 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE: 6095 Sensor Fusion Technology

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
6095	Sensor Fusion Technology	12.013	13.129	16.308	15.600	15.693	16.107	16.321	16.533	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(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, 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and assess single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets.	3.673	1.600	5.712	4.404

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

(U) In FY 2006: Continue to develop improvement in image formation and processing of SAR data from R&D data collections. Complete automated image analysis and truthing tools. Continue development of synthetic data generation tools to augment and enhance collected R&D and operational data sets. Complete initial ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Complete assessing the effectiveness of real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Continue ATR performance evaluation theory research for radar, EO, and multiple sensor ATR

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

technologies. Laboratory test the first multi-sensor ATR performance prediction model. Initiate assessment methods and measures for moving target tracking and identification (ID) approaches using multiple sensor types. Initiate development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.

(U) In FY 2007: Continue to develop improvement in image formation and processing of SAR data from R&D data collections. Continue development of synthetic data generation tools to augment and enhance collected R&D and operational data sets. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Complete initial ATR performance evaluation theory for radar ATR technology and continue for EO and multiple sensor ATR technologies. Laboratory test the first multi-sensor ATR performance prediction model. Continue assessment methods and measures for moving target tracking and ID approaches using multiple sensor types. Continue development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.

(U)

(U)	MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support ATR and sensor fusion algorithm development and testing for reconnaissance and strike mission applications.	3.853	6.372	2.946	2.730

(U) In FY 2004: Laboratory tested target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors. Generated synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Developed synthetic scene data generation capability to augment and enhance existing R&D and operational data sets. Evaluated 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) In FY 2006: Continue to mature target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence (SIGINT) sensors. Continue to develop, signatures, algorithms, and modeling support for RF and multiple EO phenomenology ATR of tactical ground

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

targets. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continue developing a synthetic scene data generation capability for RF scenes applicable to large area reconnaissance coverage. Initiate investigation of model-driven spectral signal processing and exploitation techniques. Initiate development of ATR algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high diversity data.

(U) In FY 2007: Continue to mature target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and SIGINT sensors. Continue to develop, signatures, algorithms, and modeling support for multiple RF and EO phenomenology ATR of tactical ground targets. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support ATR of targets in operationally realistic mission environments. Demonstrate a synthetic scene data generation capability for RF scenes and begin development of an EO scene capability applicable to large area reconnaissance coverage. Continue investigation of model-driven spectral signal processing and exploitation techniques. Continue development of ATR algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high diversity data.

(U)

(U)	MAJOR THRUST: Develop and demonstrate enabling ATR, sensor management, and sensor fusion technologies for target detection, tracking, and identification in ISR and CID applications.	4.487	5.157	7.650	8.466

(U) In FY 2004: Exploited adaptive learning techniques for target identification using three-dimensional sensors. Studied exploitable radar features for target detection, tracking, and identification. Laboratory tested physics-based techniques for target detection and identification for ISR and CID applications. Initiated 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) In FY 2006: Begin fusion of exploitable radar, EO/IR, LADAR, and hyperspectral features for target detection, tracking, and ID with sensor management techniques. Continue evaluation of physics-based techniques for target detection and identification for ISR and CID applications. Transition to advanced development programs laboratory demonstrated advanced algorithms for detection and identification of targets under trees and/or in the presence of heavy camouflage, concealment, and deception. Continue

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

development of technology 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. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Initiate research of bio-inspired ATR for robustness. Begin ATR, sensor management, and sensor fusion research for urban ISR from small UAVs.

(U) In FY 2007: Continue fusion of exploitable radar, EO/IR, LADAR, and hyperspectral features for target detection, tracking, and ID with sensor management techniques. Continue evaluation of physics-based techniques for target detection and ID for ISR and CID applications. Continue development of technology 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. Begin investigation of pixel level registration techniques. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continue research of bio-inspired ATR for robustness. Continue ATR, sensor management, and sensor fusion research for urban ISR from small UAVs

(U)

(U) Total Cost	12.013	13.129	16.308	15.600

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) 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 2005
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)

(U) Guidance Technology. 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
7622	RF Sensors & Countermeasures Tech	16.501	15.914	30.662	29.448	27.539	29.103	29.370	30.162	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006 efforts in Project 5017 will transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather RF sensing concepts for aerospace applications covering the range of radar sensors including ISR and fire control, both active and passive. This project also develops and evaluates technology for ISR, fire control radar, 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. Techniques exploited include the use of multiple RF phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques. 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 2004	FY 2005	FY 2006	FY 2007
	4.951	4.051	1.730	0.000

(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.

(U) In FY 2004: Evaluated multi-function EW technique waveforms. Exploited evaluations against new, advanced RF threats. Developed optimized EW techniques to degrade modern radar, communications, and missile threat systems. Performed 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) In FY 2006: Complete development and test of a complex signal communication environment simulator that contains both adversary and friendly advanced spread spectrum signals. Complete development and test of technology for an advanced digital communications jammer. Complete exploitation evaluations against new, advanced RF threats. Perform exploratory research into development of networked electronic attack techniques.

(U) In FY 2007: Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE: 7622 RF Sensors & Countermeasures Tech	

(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. Develop technologies and techniques to provide significant size, weight, and power (SWaP) reductions in RF sensors compatible with severely constrained unmanned air platforms. Develop technology to enable affordable upgrades to RF signal receivers.	2.029	1.257	6.111	14.787
(U)	In FY 2004: Developed threat identification algorithms for next generation threat warning receivers. Designed advanced very high frequency receiver improvements for detecting targets under trees. Evaluated the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, RF, microwave, etc.) component development in advanced and emerging technologies. Demonstrated 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 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)	In FY 2006: Identify and analyze advanced receiver/exciter techniques for operation with temporally and spatially adaptive electronic support (ES) and radar antenna systems. Identify and analyze advanced digital signal processing techniques that support distributed and adaptive ES and radar receiver/exciter sensor systems. Minimize SWaP for advanced apertures and receivers, waveform diversity, assured reference, and machine-to-machine sensor cross cueing. Investigate innovative techniques to provide concurrent RF radar and EW with EO compatibility on a single platform. Develop integrated radar and EW modeling, simulation, and analysis capabilities to address system-level multi-intelligence trades.				
(U)	IN FY 2007: Develop and evaluate advanced digital receiver/exciter technologies for ES and radar applications that support multiple degree-of-freedom adaptivity. Develop and evaluate advanced signal processing concepts that seamlessly integrate with receiver technologies to support increased levels of adaptivity for operation in complex signal environments. Continue development to reduce size, weight, and power in RF sensors compatible with severely constrained unmanned air platforms. Refine innovative techniques to provide concurrent RF radar and EW with EO compatibility on a single platform. Determine system-level multi-intelligence trades through integrated radar and EW modeling, simulation, and analysis.				
(U)					

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech	

(U)	MAJOR THRUST: Develop robust, ultra-widebandwidth antenna technology for use in operational and future aerospace platform electronic apertures. Develop innovative technologies and architectures for extremely wideband apertures to provide for more functionality on a set of platforms. Research of next generation applied RF aperture technology.	0.903	2.072	4.761	2.938
(U)	In FY 2004: Evaluated breadboard wideband, high-precision interferometric multi-mode direction finding antennas. Developed design tools to predict antenna performance installed on host platform models. Developed techniques that provide low-cost, lightweight phased arrays for low band applications.				
(U)	In FY 2005: Develop and laboratory demonstrate advanced wideband 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)	In FY 2006: Design and model thin profile, wideband arrays for ES receive applications. Design and fabricate array beam steering capability for wideband array jammer transmitter. Design and model compact, wideband direction finding antenna. Extend bandwidth performance of unique, low profile, low-cost antenna element.				
(U)	In FY 2007: Fabricate and test thin profile, wideband receive array. Extend array to accommodate transmit function. Evaluate performance of directional wideband array transmitter. Fabricate and test compact, wideband direction finding antenna for close in sensing.				
(U)					
(U)	MAJOR THRUST: Develop multi-function RF sensing concepts and RF transformational element level arrays for concurrent multi-mode operation.	6.448	4.644	2.944	1.855
(U)	In FY 2004: Developed and evaluated advanced multi-function and multi-intelligence RF sensors for ISR and targeting of time-critical targets. Developed testbed integration techniques for advanced multi-intelligence sensor hardware and algorithms. Developed and evaluated 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 ISR and targeting of time-critical targets with applications in UAVs and manned aircraft. Initiate testbed planning and experiment design to support validation of concepts and the subsystem requirements for advanced multi-intelligence sensors.				
(U)	In FY 2006: Fabricate and laboratory test low-cost millimeter wave sensor that provides height indication in addition to azimuth and range for landing in obscured environments. Design distributed position, navigation, and time (PNT) virtual testbed to assess assured reference techniques that achieve optimal				

multi-function RF sensor fusion for a Common Operation Picture (COP). Extend array simulations to determine technology shortfalls for full element level digital beam forming (DBF).

(U) In FY 2007: Develop distributed PNT virtual testbed to assess assured reference techniques that achieve optimal multi-function RF sensor fusion for a COP. Perform systems engineering analysis of concurrent operation to determine multi-mode array performance. Initiate technology development of critical subsystems for element level multi-mode DBF.

(U)

(U) MAJOR THRUST: Develop digital RF receiver/exciter technology to support digital beamforming.	2.170	2.036	5.507	3.920

(U) In FY 2004: Analyzed and developed approaches to address digital beamforming (DBF) issues such as coherence of multiple channels, digital true time delay, channel equalization, distributed waveform generation, and array calibration. Developed techniques for integrating multi-intelligence RF receiver/exciter subsystems into aperture and signal processing test beds.

(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) In FY 2006: Develop and model DBF-specific receiver/exciter technologies that stress reduced size, weight, and power consumption, as well as increased affordability for electronic support (ES) and radar sensor systems. Demonstrate through simulation and laboratory integration the benefits for DBF receiver/exciter technologies for multi-intelligence RF sensor systems.

(U) In FY 2007: Demonstrate receiver/exciter technologies that support DBF functionality for advanced electronic support and radar sensor systems. Perform laboratory integration and demonstration of reduced size, weight and power consumption receiver/exciter technologies that support multi-function RF sensor concepts.

(U)

(U) MAJOR THRUST: Design exploratory outdoor time transfer experiments between multiple moving platforms for enhanced situational awareness. Investigate techniques for multi-intelligence data acquisition from a single platform.	0.000	1.186	1.374	0.802

(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) In FY 2006: Demonstrate critical experiments in innovative time transfer techniques for network centric warfare applications. Develop engineering tools to implement advanced electronic

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech

counter-countermeasure (ECCM) techniques. Validate the engineering tools using both synthetic and field collected data.

(U) In FY 2007: Develop ECCM techniques capable of defeating advanced and evolving threats to long-range ISR platforms. Implement developed techniques through previously developed tools. Initiate testing of the results through synthetic data.

(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. Develop multi-platform, multi-mission radar adaptive processing algorithms that improve detection and location performance for advanced cruise missiles, air- and ground- based targets in severe clutter and jamming environments.	0.000	0.668	8.235	5.146

(U) In FY 2004: Not Applicable.

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

(U) In FY 2006: Evaluate advanced adaptive transmit waveforms for single- and multi-mode operation to improve interference rejection, self-protection, target identification, and ambiguity resolution using temporal, spatial, frequency, and polarization diversity. Initiate optimization of waveforms for multi-sensor, multi-mode operations for moving target indicator (MTI) surveillance platforms. Initiate development of advanced radar signal processing algorithms for multi-sensor, multi-mode operation. Continue to develop wideband and polarization adaptive processing techniques for multi-function radar. Evaluate adaptive processing techniques for multi-mission conformal arrays. Develop distributed processing technology for next generation deep-reach target detection and tracking.

(U) In FY 2007: Develop optimal waveforms for multi-sensor/multi-mode radar. Develop advanced radar signal processing algorithms that are suitable for multi-sensor, multi-mode operation. Evaluate wideband radar signal processing techniques for MTI surveillance platforms. Evaluate distributed processing technology for next generation deep-reach target detection and tracking.

(U)	Total Cost	16.501	15.914	30.662	29.448

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602500F, Multi-Disciplinary Space										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

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.