Exhibit R-2, PB 2010 Air Force RDT&E Budget Item Justification									DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	118.740	128.447	121.768						Continuing	Continuing
622002: Electronic Component Technology	24.370	32.189	31.041						Continuing	Continuing
622003: EO Sensors & Countermeasures Tech	26.054	19.279	17.082						Continuing	Continuing
6244SP: Space Sensors	9.951	8.886	0.000						Continuing	Continuing
624916: Electromagnetic Tech	13.926	18.271	19.137						Continuing	Continuing
626095: Sensor Fusion Technology	19.383	25.470	18.433						Continuing	Continuing
627622: RF Sensors & Countermeasures Tech	25.056	24.352	36.075						Continuing	Continuing

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) radio frequency antennas and associated electronics for airborne and space 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. 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.

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B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	121.242	109.048	104.557	
Current BES/President's Budget	118.740	128.447	121.768	
Total Adjustments	-2.502	19.399	0.000	
Congressional Program Reductions	0.000	-0.053		
Congressional Rescissions	0.000	-0.348		
Total Congressional Increases	0.000	21.400		
Total Reprogrammings	-1.412	-1.600		
SBIR/STTR Transfer	-1.090	0.000		

Change Summary Explanation

Note: In FY 2009, Congress added $1.6M for Information Quality Tools For Persistent Surveillance Data Sets; $0.8M for Net-Centric Sensor Grids; $2.8M for the Optically Pumped Atomic Laser; $2.4M for Sensor Fusion; $0.8M for Watchkeeper; $1.6M for Weather Sensors for Cursor on Target; $0.8M for Advanced Data Exploitation and Visualization; $3.0M for Low Voltage, Wideband Electro-Optic Polymer Modulators; $1.6M for Persistent Sensing Data Processing, Storage, and Retrieval; $1.6M for Space Qualification of the Common Data Link; $2.0M for the Super-Resolution Sensor System; and $2.4M for the Wideband Digital Airborne Electronic Sensing Array.

C. Performance Metrics
Under Development.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 622002	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
622002: Electronic Component Technology	24.370	32.189	31.041						Continuing	Continuing

Note

Note: In FY 2010, funds from Project 44SP are being moved to Project 2002 to better align efforts.

A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for radio-frequency sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance, electronic warfare, 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, electronic warfare, navigation, and smart weapons.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop compact, affordable, multi-function components for communications, Global Positioning System, imaging, electronic warfare, intelligence, surveillance, and reconnaissance sensors. Develop advanced electronic and optoelectronic aperture subsystems that support affordable and scalable sensors. Develop sources and detectors for electronic and optoelectronic sensors. Develop metamaterials for conformal arrays. Note: In FY 2009, this increase in funding is due to greater emphasis on metamaterials. Decrease in FY 2010 reflects the transfer of all efforts except metamaterials to other Major Thrusts. In FY 2008: Developed integrated wideband multi-channel phased array subarray with digital receiver and exciter architecture for future multi-intelligence electronic warfare and radar applications. Finished demonstration of distributed receiver/exciter architecture for advanced multi-function systems used in radar and electronic warfare sensors.	4.704	10.707	6.395	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2009: Demonstrate integrated wideband subarray for future multi-intelligence electronic warfare and radar applications. Design and develop digital receiver components to enable full digital receiver and exciter capabilities per transmit/receive site to enable future software-controlled phased arrays. Develop new hardware to exploit emerging metamaterials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Evaluate the potential for highly-integrated electronics and apertures using low electromagnetic interference integrated devices and circuits through the use of metamaterials as three-dimensional electronic building blocks including laboratory prototyping of electrically small, compact radiating elements. In FY 2010: Demonstrate prototype wideband digital channel. Continue to develop and exploit metamaterials for electronic and optoelectronic applications. Demonstrate sensing subsystem using most promising metamaterials technology.					
MAJOR THRUST: Develop new microelectronic component technologies for radar, electronic warfare, and communications to support intelligence, surveillance, reconnaissance, precision strike, and battlespace access capabilities using advances in material research and microelectronic fabrication techniques. In FY 2008: Fabricated and performed lab testing to investigate physical and chemical properties of microcircuits under operating conditions to understand operating lifetime-limiting changes in structure. Continued development of electronics modeling and assessment techniques. Developed flexible and visually-transparent radio-frequency electronics. In FY 2009: Continue fabrication and lab testing to investigate physical and chemical properties of microelectronics to develop models to predict failure modes and lifetimes. Further refine electronics modeling and assessment techniques. Demonstrate flexible and visually-transparent radio-frequency electronics.		6.223	5.419	4.273	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Demonstrate closed-loop modeling and prediction capability for emerging electronic device performance versus lifetime in militarily relevant environments. Investigate and test innovative electronic device concepts for wideband, reconfigurable and tunable applications.					
MAJOR THRUST: Develop optoelectronics for next generation imaging and electronic warfare sensors. Develop electro-optical devices for next-generation warfighter applications. In FY 2008: Demonstrated photonic radio-frequency modulation components for radio-frequency links and arbitrary electro-optical waveform generation. Continued development of vertical external cavity surface emitting lasers as compact, efficient, high-brightness sources. Continued development of fiber-optics and optical components for high-power mid-infrared applications. In FY 2009: Continue development of vertical external cavity surface emitting lasers as compact, efficient, high-brightness sources. Complete development of fiber-optics and optical components for high-power mid-infrared applications. Develop ultra-stable, tunable, mode-locked lasers to enable highly integrated optical waveform generation. In FY 2010: Demonstrate compact, efficient, high-brightness sources, optically- and/or electrically-pumped. Start the development for compact, tunable detector technology for advanced multi-spectral applications. Continue development of optical waveform generation subsystems. Initiate effort for combined spectral and polarimetric filtering at detector pixel level; extending to next-generation spectro-polarimetric focal plane array development.		3.183	4.301	3.833	
MAJOR THRUST: Develop, fabricate, and test electronic and optoelectronic components and techniques to reduce both power loss and power consumption for future imaging, electronic warfare, and intelligence, surveillance, and reconnaissance sensors. Develop and integrate adaptable circuit technologies that utilize dynamic elements and low-loss signal control for multi-function imaging and electronic warfare sensors used		3.738	2.256	8.726	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors			PROJECT NUMBER 622002	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
for intelligence, surveillance, reconnaissance, and battlespace access capabilities. Increase in FY 2010 reflects the realignment of efforts within the Project. In FY 2008: Developed and demonstrated adaptable microcircuits for multi-function sensors. Emphasized emerging electronic approaches for energy-starved circuit applications. In FY 2009: Develop tunable and reconfigurable wideband amplifiers for use in multi-function radar and electronic warfare sensors. Emphasize emerging electronics approaches for energy-starved circuit applications. In FY 2010: Demonstrate tunable and reconfigurable electronic and optoelectronic components for combined imaging and electronic warfare applications. Continue development of solutions for energy starved applications.					
MAJOR THRUST: Exploit promising emerging electronics concepts for imaging and electronic warfare from devices to subsystems for intelligence, surveillance, reconnaissance, and battlespace access capabilities. Develop and demonstrate innovative radio-frequency component technology that lowers system cost through reduction of design costs, part count, chip size, production costs, and integration costs. In FY 2008: Investigated microcircuit integration modeling and simulation tools to enable two-dimensional and three-dimensional electronics. In FY 2009: Develop and demonstrate highly integrated phase control components for use in wideband multi-function sensors. In FY 2010: Design and develop highly reconfigurable fully programmable microwave array and flexible optoelectronic integrated circuits using highly integrated techniques for lighter weight radio-frequency and optical apertures.		3.261	1.861	1.017	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop and validate the integrated design, modeling and simulation tools, and integration techniques for complex mixed-signal (digital, radio-frequency, microwave, etc.) component development in both advanced and emerging electronic component technologies. Increase in FY 2010 reflects the realignment of efforts within the Project. In FY 2008: Continued design and refinement of models for next-generation high-power components that operate under extreme conditions and enable multi-function sensors. In FY 2009: Demonstrate closed loop characterization of performance driven component and device design, fabrication, and characterization with first pass success. In FY 2010: Extend design and characterization capability to tunable, reconfigurable and multi-function electronic and optoelectronic devices and components.		3.261	1.861	5.149	
MAJOR THRUST: Develop advanced component technology for space-base sensors that focuses on improving performance and reducing size, mass, and prime power. Utilize advanced materials to demonstrate low-mass, low cost, reliable, and scalable apertures. Develop advanced active phased array antenna subsystems to meet the unique requirements of affordable space-based sensing including the restrictions on mass, size, and power. Supports intelligence, surveillance, and reconnaissance capabilities. Note: Prior to FY 2010, this effort was performed in Project 44SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Develop reconfigurable/tunable high performance electronics/circuits. Investigate pre-space qualification issues associated with newer component technologies to ensure more rapid and accurate transitions. Develop scalable/reconfigurable plug-and-play payload building blocks.		0.000	0.000	1.648	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
CONGRESSIONAL ADD: Optically Pumped Atomic Laser (OPAL). Note: In FY 2008, this effort was conducted as part of Project 2003. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for the OPAL. In FY 2010: Not Applicable.	0.000	2.792	0.000	
CONGRESSIONAL ADD: Low Voltage, Wideband Electro-Optic Polymer Modulator. Note: In FY 2008, this effort was conducted as part of Project 2003. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Low Voltage, Wideband Electro-Optic Polymer Modulator. In FY 2010: Not Applicable.	0.000	2.992	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Technology.	0.000	0.000							Continuing	Continuing
PE 0603203F/ Advanced Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0603270F/ Electronic Combat Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 622003	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
622003: EO Sensors & Countermeasures Tech	26.054	19.279	17.082						Continuing	Continuing

Note

Note: In FY 2010, funds from Project 44SP move to Project 2003 within this Program Element to better align efforts.

A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared 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 electro-optical 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 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 electro-optical threat warning and countermeasures.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop technology for non-cooperative detection and identification of airborne, space, and ground-based targets. In FY 2008: Performed phenomenology experiments for multi-discriminant active/passive sensing and performed sensor concept modeling. Collected signature data for target discrimination and shape extraction using passive multispectral and polarimetric sensing techniques. Characterized the performance of a long-wave hyperspectral sensor for performing identification of gaseous targets. Demonstrated hybrid focal planes and read-out electronics for simultaneous multi-discriminant active and passive sensing, and developed image processing techniques for sensor data enhancement. Continued development of vibration signature catalogs, performance and signature models, and processing including initial automatic target recognition (ATR). In FY 2009: Perform sensor concept demonstrations for multi-discriminant active and passive sensing and quantify expected system performance. Characterize target discrimination and shape extraction performance using passive multispectral and polarimetric sensing techniques. Continue demonstration of hybrid focal	2.335	2.864	2.344	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
planes and read-out electronics for simultaneous multi-discriminant active and passive sensing, and refine image processing techniques for sensor data enhancement. Perform trade-off studies for long range target identification using passive and active techniques, including polarimetric discrimination and synthetic aperture laser radar. In FY 2010: Perform sensor concept demonstrations for long range target identification using passive and active techniques, including multispectral/polarimetric imaging, vibrometry, sparse aperture and synthetic aperture laser radar. Develop fused active and passive, multi-discriminant image products based on individual and combined measurement performance. Continue characterization of hybrid focal planes and demonstrate in short range ladar systems. Begin design of multi-discriminant system utilizing common components to minimize size and optimize utility. Continue optical sensor enhancements for improved space situation awareness experiments.					
MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification. Funding decreases in FY 2010 due to the completion of the sparse aperature testbed in FY 2009. In FY 2008: Extended development and testing of optical transmitter technologies for non-cooperative target identification to increased standoff ranges. Explored optical discriminants for long range identification including shape, polarization, and vibration using real-beam and synthetic aperture sensing techniques. Developed a sparse aperture testbed supporting spatial synthesis imaging. Developed advanced models to support phenomenology-driven sensor trade studies with both active and passive sensors. Performed tower and flight collections to validate system modeling results. Explored enabling sensor components to support extended range operation. In FY 2009: Continue development and testing of optical transmitter technologies for non-cooperative target identification at long standoff ranges. Perform multi-function signature collections for long-range identification including shape, polarization, and vibration using real-beam and synthetic aperture sensing techniques. Complete development of sparse aperture testbed supporting spatial synthesis imaging. Develop optimal		6.548	5.275	0.514	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
system concepts using advanced active and passive sensor models. Continue tower and flight collections to quantify expected performance. Develop enabling sensor components for a long-range demonstration system. In FY 2010: Complete testing of optical transmitter technologies for non-cooperative target identification at long standoff ranges. Continue to refine optimal system concepts using advanced active and passive sensor models with emphasis on imaging through scattering media such as clouds and foliage. Develop enabling sensor components for a demonstration system.					
MAJOR THRUST: Develop innovative techniques and components to target difficult objects in battlefield environments. In FY 2008: Extended development of techniques for targeting difficult objects in dynamic urban environments. Developed passive infrared components and techniques for continuous surveillance of broad areas with detection and tracking of dynamic targets and events. Continued development of non-mechanical beam steering for both passive and active sensors. Explored passive and active laser detection and range-sensing phenomenology techniques for capturing robust spectral, spatial, polarimetric, and radiometric signatures for moving target identification and track association in dense target areas. In FY 2009: Continue development of techniques for targeting difficult objects in dynamic urban environments. Perform concept demonstrations of continuous passive infrared surveillance of broad areas with detection and tracking of dynamic targets and events. Develop sensor concept designs for optimizing revisit rate and perform design trade-off experiments. Develop concepts for close-in sensing from UAV or small UAVs in difficult environments. Investigate small unmanned aerial vehicles (SUAV) applications of non-mechanical beam steering for pointing and stabilization. Perform spectral, spatial, polarimetric, and radiometric signature collection experiments using laboratory passive and active laser detection and ranging sensors for moving target identification and track association in dense target areas. In FY 2010: Continue development of techniques for targeting difficult objects in dynamic urban environments. Explore compact active and passive sensor components with advanced signal processing for distributed		3.596	4.738	6.093	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
operation from small platforms to provide close-in sensing of difficult targets in obscured and urban areas. Demonstrate individual sensor components for close in sensing from SUAVs in difficult environments. Conduct flight phenomenology experiments supporting ladar applications on SUAVs.					
MAJOR THRUST: Develop countermeasure technologies for use against infrared- and electro-optical guided missiles threats. Increased funding in FY 2010 reflects increased emphasis in countering advanced threats. In FY 2008: Continued development of second-generation infrared-imaging missile seeker models and simulations for countermeasure technique development. Continued exploitation of advanced infrared missiles and infrared acquisition sensors for countermeasure technique updates and refinement. Initiated identification of discriminants for specific identification of new electro-optical sensors and missile threats. In FY 2009: Evaluate countermeasure techniques to defeat second-generation infrared-imaging missile seekers. Develop new countermeasure technique updates and refinements applicable to legacy systems. Continue identification of discriminants for specific identification of new electro-optical sensors and missile threats. In FY 2010: Assess technologies to defeat advanced infrared missiles and infrared acquisition sensors. Support demonstration of proactive detection, discrimination, and defeat of second-generation infrared-imaging missile seekers and sensors systems. Refine techniques and discrimination processes test data. Develop and refine simulation capability to evaluate effectiveness across mission concepts of employment.		2.591	2.877	7.672	
MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue countermeasures. In FY 2008: Continued developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Identified methods to increase focal plane array dynamic range for precise characterization of low- and high-power laser threats.		0.546	0.732	0.459	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2009: Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Identify clutter suppression techniques to increase signal to noise and improve detection ranges in urban operations. Evaluate algorithms to optimize detection and declaration ranges. In FY 2010: Support integration of new laser warning sensors with countermeasures system prototypes to provide robust capability to detect threats and cue defeat techniques. Refine sensor hardware and software design based on test data. Conduct demonstration testing of integrated capabilities. Develop new laser warning concepts to address emerging directed energy threats.					
CONGRESSIONAL ADD: Super-resolution Sensor System (S3). In FY 2008: Conducted Congressionally-directed effort for the Super-resolution Sensor System. In FY 2009: Continue to conduct Congressionally-directed effort for the Super-resolution Sensor System. In FY 2010: Not Applicable.		4.923	1.995	0.000	
CONGRESSIONAL ADD: Optically Pumped Atomic Laser (OPAL). Note: In FY 09, this effort continues under Project 2002. In FY 2008: Conducted Congressionally-directed effort for the OPAL. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		3.151	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
CONGRESSIONAL ADD: Low Voltage, Wideband Electro-Optic Polymer Modulator. Note: In FY 09, this effort continues under Project 2002. In FY 2008: Conducted Congressionally-directed effort for Low Voltage, Wideband Electro-Optic Polymer Modulator. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	2.364	0.000	0.000	
CONGRESSIONAL ADD: Watchkeeper. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for the Watchkeeper. In FY 2010: Not Applicable.	0.000	0.798	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Technology.	0.000	0.000							Continuing	Continuing
PE 0603253F/ Advanced Sensor Integration.	0.000	0.000							Continuing	Continuing
PE 0602301E/ Intelligence System Program.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 6244SP	
COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
6244SP: Space Sensors	9.951	8.886	0.000						Continuing	Continuing

Note

Note: In FY 2010, funds from Project 44SP are being moved to Projects 2002, 2003, and 7622 to better align efforts.

A. Mission Description and Budget Item Justification

This project focuses on developing methods of generating, controlling, receiving, transmitting, and processing electronic, photonic, optical, and opto-electronic (mixed) signals for radio frequency space sensor applications. The enabling technologies will be used for intelligence, surveillance, reconnaissance, electronic warfare, and precision engagement sensors based in space. This project develops the baseline technologies required to manage and perform on-board space sensor information fusion for timely and comprehensive communications and situational awareness. Through modeling and simulation, this project develops and evaluates innovative electromagnetic and electronic countermeasures for space applications. This project aims to demonstrate significantly improved military space sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. This project also develops and assesses multi-dimensional adaptive techniques in radar technology for affordable and reliable space surveillance and reconnaissance systems.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop hybrid space-based sensor solutions and reduce associated technology risks. Investigate hardware and software implementation approaches for the needs of responsive space needs and of difficult targets from space. Develop space-qualified precision time, position, and velocity sensors capable of operating in jamming environments while enabling multiple platform sensor-to-warfighter operations. In FY 2008: Defined specific responsive space sensor functional capabilities and implementation assessments. Modeled size-, weight-, and power-restricted precision time, position, and velocity sensor techniques for space-based applications. Developed constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility. In FY 2009: Experimentally assess responsive "plug-and-play" satellite implementation concept. Design size-, weight-, and power-restricted precision time, position, and velocity sensor techniques for space-based applications. Demonstrate constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility.	3.031	2.738	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors	PROJECT NUMBER 6244SP

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Not Applicable.				
MAJOR THRUST: Develop advanced active phased array antenna subsystems to meet the unique requirements of affordable space-based sensing including restrictions on mass, size, and power. Utilize advanced materials to demonstrate low-mass, low cost, reliable, and scalable apertures. Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. Supports intelligence, surveillance, and reconnaissance capabilities. In FY 2008: Developed sub-array level digital beam-forming and low-cost L-band antenna panels. In FY 2009: Experimentally assess enhanced antenna signal interference compatibility capability. In FY 2010: Not Applicable.	3.311	2.230	0.000	
MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays to meet the stringent demands of wide area coverage, target detection and target tracking in severe clutter and interference environments. In FY 2008: Evaluated adaptive transmit and receive techniques for surface moving target indication from space under a variety of tactical scenarios and interference environments. In FY 2009: Integrate the developed algorithms, waveforms, and space platform scenarios into a surveillance network of sensors. In FY 2010: Not Applicable.	1.489	1.030	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009	
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop advanced component technology for space-based sensors that focuses on improving performance and reducing size, mass, and prime power. Investigate pre-space qualification issues associated with newer component technologies to ensure more rapid and accurate transitions. Supports intelligence, surveillance, and reconnaissance capabilities. In FY 2008: Validated new low-cost radio-frequency sub-assembly technology compatibility for space qualification. Evaluated plastic packaging, liquid crystal polymer packages, and flexible radio-frequency boards. In FY 2009: Develop compact tunable filters for interference signal rejection in dense signal environments. In FY 2010: Not Applicable.	0.882	1.501	0.000	
MAJOR THRUST: Develop sensor techniques to achieve highly accurate and robust navigation performance for hypersonic air vehicles in prompt global strike applications. Note: This work is an outgrowth of other efforts within this Project. In FY 2008: Modeled hypersonic air vehicle plasma characteristics, platform trajectories, and highly accurate and robust navigation techniques for space-based applications. Developed a constructive systems engineering model to assess hypersonic navigation techniques in terms of measures of performance and warfighter utility. In FY 2009: Design a radio-frequency hardware-in-the-loop testbed to implement hypersonic air vehicle plasma characteristics, platform trajectories, and highly accurate and robust navigation techniques for space-based applications. Continue developing a constructive systems engineering model to assess hypersonic navigation techniques in terms of measures of performance and warfighter utility. In FY 2010: Not Applicable.	1.238	1.387	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Tech.	0.000	0.000							Continuing	Continuing
PE 0603203F/ Advanced Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0603500F/ Multi-Disciplinary Adv Dev Space Tech.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 624916	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
624916: Electromagnetic Tech	13.926	18.271	19.137						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops technologies for sensor systems that cover the electromagnetic spectrum from radio-frequency to electro-optical. It develops radio-frequency antennas and associated electronics for airborne and space-based surveillance. It also investigates radio-frequency scattering phenomenology for applications in ground and air moving target indicators in extremely cluttered environments. The project develops active and passive electro-optical sensors for use in concert with radio-frequency 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.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Investigate detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms. In FY 2008: Developed techniques for fully-adaptive sensing and processing combining electromagnetic phenomenology, cognitive algorithms, and signal processing pertaining to waveform diverse sensing and distributed sensing. In FY 2009: Develop analytical and computationally efficient tools for multi-sensor integration for target detection, tracking, and classification in a knowledge-aided framework exploiting physics-based and data dependent electromagnetic models of targets and clutter. In FY 2010: Continue to develop analytical and computationally efficient tools for multi-sensor integration for target detection, tracking, and classification in a knowledge-aided framework exploiting physics-based and data dependent electromagnetic models of targets and clutter.	3.037	2.593	3.144	
	3.237	6.502	6.807	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance. Develop metamaterials for conformal arrays. Note: In FY 2009, this increase in funding is due to greater emphasis on metamaterials. In FY 2008: Integrated optimal algorithms with mixed circuit radio-frequency wide-band beam-forming hardware to demonstrate lower cost lightweight sensor platforms. Demonstrated low-cost miniature seeker hardware. Transitioned newly developed digital beamforming architectures to new airborne radar platforms. In FY 2009: Develop new low-cost digital beamforming techniques for miniature unmanned aerial vehicles. Integrate new detection algorithm with low cost seeker hardware. Integrate and test new conformal digital beamforming phased array antennas on airborne radar platforms. Develop new hardware to exploit emerging metamaterials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Assess the viability of obtaining metamaterial properties consistent with the demonstration of highly integrated subsystems based upon radio frequency integrated circuit applications to enable small, highly directional antenna element device drivers. In FY 2010: Continue to develop new low-cost digital beamforming techniques for miniature unmanned aerial vehicles. Integrate new detection algorithm with low cost seeker hardware. Continue integration and test of new conformal digital beamforming phased array antennas on airborne radar platforms. Continue to develop new hardware to exploit emerging metamaterials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Continue to assess the viability of obtaining metamaterial properties consistent with the demonstration of highly integrated subsystems based upon radio frequency integrated circuit applications to enable small, highly directional antenna element device drivers.				
MAJOR THRUST: Design and develop new electro-optical techniques and components for detecting and identifying concealed targets. In FY 2008: Developed new focal plane array materials and avalanche photo-detector device technologies to enhance autonomous munitions, staring focal plane arrays, and target identification and tracking applications.	2.645	3.848	5.523	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Developed two-dimensional pixel-based electronic control circuits for enhanced imaging. Integrated these focal plane arrays with the electronic control circuits for a compact three-dimensional focal plane array capability. In FY 2009: Develop new quasi-phase matched materials such as Gallium Phosphate and techniques for efficient optical sources in the mid- and long-wave infrared applications. New materials systems will be developed to enable conversion from pump wavelengths between 1 and 2 microns. Continue testing of integrated focal plane arrays. In FY 2010: Continue to develop new quasi-phase matched materials such as Gallium Phosphate and techniques for efficient optical sources in the mid- and long-wave infrared applications. Continue developing new materials systems to enable conversion from pump wavelengths between 1 and 2 microns. Continue testing of integrated focal plane arrays.				
MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates. In FY 2008: Performed critical technical assessments via field testing on hyperspectral electro-optical sensors developed in prior years. Evaluated the potential of sensing rapidly changing electro-optical spectra from hot battlefield events (for example, rocket propelled grenades, mortars, man-portable air defense systems, and muzzle flash). Used results of collections to define small portable systems that can be fielded to provide rapid tactical information to commanders about the location and type of weapons being fired at friendly forces. Performed initial testing on a new hyperspectral approach to finding and identifying toxic gas clouds. In FY 2009: Develop new electro-optical sensor hardware for detecting chemical, biological, radioactive, nuclear, or high explosive weapons using spectral/hyperspectral intelligence. Perform initial testing to assess sensor detection and identification viability and initiate plan for transition. Continue development of hyperspectral and multispectral sensors and create a small, deployable instrument suitable for moving into transition with an advanced technology demonstrator. Initiate utility assessment of hyperspectral sensors for collecting data at millisecond sample rates for space-based applications.	3.235	2.935	3.663	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Continue to develop new electro-optical sensor hardware for detecting chemical, biological, radioactive, nuclear, or high explosive weapons using spectral/hyperspectral intelligence. Continue testing to assess sensor detection and identification viability and initiate plan for transition. Continue development of hyperspectral and multispectral sensors and create a small, deployable instrument suitable for moving into transition with an advanced technology demonstrator. Continue utility assessment of hyperspectral sensors for collecting data at millisecond sample rates for space-based applications. Apply spectral temporal sensor technology for cueing electro-optical and infrared persistent surveillance sensors.					
CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas. In FY 2008: Conducted Congressionally-directed effort for the Center for Advanced Sensor and Communication Antennas. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.984	0.000	0.000	
CONGRESSIONAL ADD: Optimal Maximum Entropy Verification (OMEV). In FY 2008: Conducted Congressionally-directed effort for Optimal Maximum Entropy Verification (OMEV). In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.788	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
CONGRESSIONAL ADD: Wideband Digital Airborne Electronic Sensing Array (WDAESA). In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for WDAESA. In FY 2010: Not Applicable.	0.000	2.393	0.000	

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Technology.	0.000	0.000							Continuing	Continuing
PE 0602702F/ Command Control and Communications.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
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E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 626095	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
626095: Sensor Fusion Technology	19.383	25.470	18.433						Continuing	Continuing

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, 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. This project also develops the technologies required to create trusted autonomic, distributed, collaborative, and self-organizing sensor systems that provide anticipatory and persistent intelligence, surveillance, and reconnaissance (ISR) situational awareness and decision support for multi-layered sensing. This program provides the technologies for: 1) trusted sensors and trusted sensor systems that will deter reverse engineering and exploitation of our critical hardware and software technology and impede unwanted technology transfer, alteration of system capability, and prevent the development of countermeasures to U.S. systems; 2) collaborative tasking of our own distributed heterogeneous sensor networks across a region and co-opted tasking of both traditional and non-traditional adversary sensors; 3) secure sensor web backbone technologies, sensor web physical topologies, and related protocols to assure reliable trusted sensor interactions; and 4) defining architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks, developing new methodologies for system of systems sensor engineering and analysis, and new techniques for sensor network situation awareness and predictive analytics.

B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop and assess single and multi-sensor automatic target recognition and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. In FY 2008: Developed improved image formation and processing of synthetic aperture radar data from research and development data collections. Continued to develop image and data formation and processing of electro-optical, infrared, hyper-spectral imagery data from research and development data collections. Continued development of multi-sensor and multi-frequency synthetic data generation tools to augment and enhance collected research, development, and operational data sets. Continued laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Enhanced automatic target recognition performance evaluation theory for radar automatic target recognition technology and continued for electro-optical and multiple-sensor automatic target recognition	1.240	1.414	2.019	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
technologies. Continued assessment methods and measures for moving target tracking and identification approaches using multiple sensor types. Continued development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations. In FY 2009: Assess the image formation and processing of synthetic aperture radar, electro-optical/infrared/ hyper-spectral imagery data from research and development data collections taking advantage of disparate phenomenology to improve automatic target recognition detection, classification and identification performance. Develop and validate multi-sensor/multi-frequency synthetic data generation tools required to augment and enhance collected research, development, and operational data sets. Initiate development of tools and technology supporting other phenomenological features that heretofore have not been exploited. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Enhance automatic target recognition performance evaluation theory for radar automatic target recognition technology and continue for electro-optical and multiple-sensor automatic target recognition technologies. Continue assessment methods and measures for moving target tracking and identification 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. In FY 2010: Continue to assess the image formation and processing of synthetic aperture radar, electro-optical/infrared/hyper-spectral imagery data from research and development data collections taking advantage of disparate phenomenology to improve automatic target recognition detection, classification and identification performance. Continue to develop and validate multi-sensor/multi-frequency synthetic data generation tools required to augment and enhance collected research, development, and operational data sets. Search out unexploited phenomenological features and initiate development of tools and technology required to exploit said features. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Continue enhancements to databases, tools and laboratory environments as required to support assessment and validation of models and exploitation technologies. Continue to improve automatic target recognition performance evaluation theory for automatic target recognition technologies. Continue to develop assessment methods and measures for moving target tracking and identification approaches using multiple sensor types. Continue development of analysis methods				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.					
MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support automatic target recognition and sensor fusion algorithm development and testing for reconnaissance and strike mission applications. In FY 2008: Developed and validated target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors. Developed signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of tactical ground targets; introduce civilian vehicles. Continued to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continued demonstration of a synthetic scene data generation capability for radio-frequency scenes and continued development of an electro-optical scene capability applicable to large area reconnaissance coverage. Continued investigation of model-driven spectral signal processing and exploitation techniques. Measured performance of initial automatic target recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high-diversity data. In FY 2009: Continue to mature target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors. Continue to develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of tactical ground targets. Initiate the development of signatures, algorithms, target modeling, and phenomenological modeling of other phenomenological features that heretofore have not been exploited. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continue demonstration of a synthetic scene data generation capability for radio-frequency scenes and continue development of an electro-optical scene capability applicable to large area reconnaissance coverage. Continue investigation of model-driven spectral signal processing and exploitation techniques. Continue development of automatic target		3.137	3.480	4.838	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high-diversity data. In FY 2010: Continue to mature target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors emphasizing one target model for application to all parts of the spectrum. Continue to develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of ground targets. Continue search for and the development of signatures, algorithms, target modeling and phenomenological modeling of other phenomenological features that heretofore have not been exploited. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support development and assessment of automatic recognition of targets in operationally realistic mission environments. Continue demonstration of large area, reconnaissance coverage, synthetic scene data generation capability for radio-frequency and electro-optical sensors. Continue investigation of model-driven spectral signal processing and exploitation techniques. Continue development of automatic target recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high-diversity data.				
MAJOR THRUST: Develop and demonstrate enabling automatic target recognition, sensor management, and sensor fusion technologies for target detection, tracking, and identification in intelligence, surveillance, reconnaissance, and combat identification applications. Note: In FY 2010, efforts were reduced in this Project due to higher AF priorities. In FY 2008: Developed and validated a fusion capability of exploitable radar, electro-optical, infrared, laser detection and ranging, and hyperspectral features for target detection, tracking, and identification with sensor management techniques. Evaluated physics-based techniques for target detection and identification for intelligence, surveillance, and reconnaissance and combat identification applications. Initiated development of automated battle space behavior analysis. Continued development and initiated assessment 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. Continued development of multi-sensor pixel level registration techniques. Continued development of capabilities to represent and utilize sensor	8.377	5.136	1.940	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continued research of bio-inspired automatic target recognition for robustness. Extended automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles to include civilian objects of interest. In FY 2009: Complete initial fusion capability for radar, electro-optical/infrared, laser detection and ranging, and hyperspectral features for target detection, tracking, and identification with sensor management techniques. Evaluate and improve of physics-based techniques for target detection and identification for intelligence, surveillance, and reconnaissance and combat identification applications. Continue development and initiate evaluation of automated battle space behavior analysis. 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; initiate its inclusion into fusion functions. Complete and evaluate multi-sensor, 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 automatic target recognition for robustness and initiate evaluation of these techniques for urban applications. Evaluate automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles. In FY 2010: Demonstrate and assess fusion capability for radar, electro-optical/infrared, laser detection and ranging, and hyperspectral features for target detection, tracking, and identification with sensor management techniques. Enhance physics-based techniques to meet the target detection and identification requirements for intelligence, surveillance, and reconnaissance and combat identification applications. Continue development and evaluation of automated battle space behavior analysis. Continue development and assessment of technology that will fuse precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing. Enhance multi-sensor, pixel level registration techniques as necessary to support requirements. Continue to assess and develop 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 automatic target recognition technologies and continue to assess and evaluate these techniques for all missions with emphasis				

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
on urban applications. Evaluate automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles.					
MAJOR THRUST: Develop fundamental technical methods required for algorithm performance models, automatic target recognition driven sensing, layered sensing and other sensing and exploitation technologies impacted by automatic target recognition capabilities. Note: This work is an outgrowth of other work within this project. In FY 2008: Assessed the state of the art in automatic target recognition predictive methods. Determined exploitation and sensing technologies that require the integration of automatic target recognition techniques. Developed fundamental automatic target recognition approaches for various subcomponents. In FY 2009: Evaluate new innovations in automatic target recognition-related technologies. Continue development of fundamental automatic target recognition approaches for subcomponents. Begin development of an integrated, unified automatic target recognition methodology, building upon the various automatic target recognition subcomponent efforts. In FY 2010: Continue evaluation of new innovations in automatic target recognition-related technologies. Continue development of fundamental automatic target recognition approaches for subcomponents. Begin development of a capability to model the performance of these technologies. Determine methods of performance modeling validation. Develop databases and tools required to support performance modeling and assessment. Continue development of an integrated, unified automatic target recognition methodology building upon the modeling and assessment tools developed.		1.466	1.500	1.477	
MAJOR THRUST: Develop, evaluate, and demonstrate methodologies, techniques, and strategies to instill trust in distributed, heterogeneous sensing systems within air, space, and cyber application domains.		3.588	4.488	4.805	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Developed new technologies and methodologies for defining adaptive architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks. Developed new techniques for system of systems sensor engineering and analysis. Initiated development of new techniques for sensor network situational awareness and predictive analytics to optimize object driven, self-organizing collaborative sensor systems for multi-layered sensing. In FY 2009: Continue development of new technologies and methodologies for defining adaptive architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks. Continue to develop new techniques for system of systems sensor engineering and analysis. Continue to develop new techniques for sensor network situational awareness and predictive analytics to optimize object driven, self-organizing collaborative sensor systems for multi-layered sensing. Initiate research into sensor network science to identify critical areas and technologies needed for next generation semantic sensor networks. In FY 2010: Complete development of new techniques for systems sensor engineering and analysis. Complete development of new techniques for sensor network situational awareness and global measures of trust for multi-layered sensing. Complete development of representative measures of system trustworthiness for collaborative and distributed heterogeneous sensing system architectures and semantic sensor networks. Continue development of new technologies and methodologies for producing adaptive, trusted architectures for multi-layered sensing.					
MAJOR THRUST: Develop, assess, evaluate, and demonstrate technologies that enable autonomic trusted features in sensor systems to deter reverse engineering and exploitation of critical military hardware and software systems. This effort is brokenout separately in FY 2010 due to increased emphasis on developing trusted system technology. In FY 2008: Not Applicable. In FY 2009: Not Applicable.		0.000	0.000	1.102	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Develop and demonstrate critical technologies for trusted sensors for multi-layered ISR sensing systems to assure anti-tamper and software protection of key military capabilities. Assess and evaluate commercial technologies for application to military trusted systems. Develop and demonstrate secure cyber sensing station for ISR and cyberspace applications. Initiate development of autonomic trusted sensor technologies to address self-ware, self-healing, and self-organizing sensor systems.				
MAJOR THRUST: Develop, evaluate, and demonstrate secure backplane, integration technology, physical topologies, and related protocols to support multi-layered sensing and trusted sensor networks for air, space, and cyber domains. This effort is broken out separately in FY 2009 due to increased emphasis in development of integrated multi-layer sensor technology. In FY 2008: Not Applicable. In FY 2009: Initiate development of conceptual design of sensor web backbone technology to assure trusted sensor interactions for multi-layered persistent ISR sensing leveraging commercial infrastructure and components. Initiate development of sensor web backbone integration laboratory to assess and evaluate critical sensor data link technologies and physical topologies for secure sensor networks. In FY 2010: Complete conceptual design conceptual design of sensor web backbone technology to assure trusted sensor interactions for multi-layered persistent ISR sensing. Continue development of sensor web backbone integration laboratory. Complete initial assessment of available sensor technologies for trusted sensing. Initiate development of advanced sensor bus technologies for trusted sensing. Initiate analysis to exploit wired and wireless sensor web systems.	0.000	2.270	2.252	
CONGRESSIONAL ADD: Sensor Fusion. In FY 2008: Conducted Congressionally-directed effort for Sensor Fusion.	1.575	2.394	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2009: Conduct Congressionally-directed effort for Sensor Fusion. In FY 2010: Not Applicable.				
CONGRESSIONAL ADD: Advanced Data Exploitation and Visualization. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Advanced Data Exploitation and Visualization. In FY 2010: Not Applicable.	0.000	0.798	0.000	
CONGRESSIONAL ADD: Information Quality Tools for Persistent Surveillance Data Sets. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Information Quality Tools for Persistent Surveillance Data Sets. In FY 2010: Not Applicable.	0.000	1.596	0.000	
CONGRESSIONAL ADD: Net-Centric Sensor Grids. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Net-Centric Sensor Grids.	0.000	0.798	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Not Applicable.				
CONGRESSIONAL ADD: Persistent Sensing Data Processing, Storage and Retrieval. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Persistent Sensing Data Processing, Storage and Retrieval. In FY 2010: Not Applicable.	0.000	1.596	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Technology.	0.000	0.000							Continuing	Continuing
PE 0603203F/ Advanced Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0602602F/ Conventional Munitions.	0.000	0.000							Continuing	Continuing
PE 0603270F/ Electronic Combat Technology.	0.000	0.000							Continuing	Continuing
PE 0603226E/ Experimental Evaluation of Major Innovative Technologies.	0.000	0.000							Continuing	Continuing
PE 0603762E/ Sensor and Guidance Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
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E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602204F Aerospace Sensors					PROJECT NUMBER 627622	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
627622: RF Sensors & Countermeasures Tech	25.056	24.352	36.075						Continuing	Continuing

Note

Note: In FY 2010, funds from Project 44SP are being moved to Project 7622 to better align efforts.

A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather radio-frequency sensing and countermeasure concepts for aerospace applications covering the range of radio frequency sensors including communications, navigation, intelligence, surveillance, reconnaissance, and radar, both active and passive, across the air, land, sea, space and cyber domains. This project also develops and evaluates technology for intelligence, surveillance, and reconnaissance sensors, fire control radars, electronic warfare, integrated radar and electronic warfare systems, and offensive information operations systems. It emphasizes the detection and tracking of surface and airborne targets with radio-frequency 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 radio-frequency phenomenologies, multi dimensional adaptive processing, advanced waveforms and knowledge-aided processing techniques. This project also develops the radio-frequency warning and countermeasure technology for advanced electronic warfare and information operations applications. Specifically, it develops techniques and technologies to detect and counter the communications 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 radio-frequency sensors, including radar warning, radio-frequency electronic warfare, and electronic intelligence applications.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop technologies and techniques to provide significant size, weight, and power (SWaP) reductions in radio-frequency sensors compatible with severely constrained unmanned air platforms. Reduced SWaP enables sensor installations on small unmanned aerial systems which could not otherwise carry RF sensors, and improved sensor performance through additional capability on larger platforms. Develop technology for optimal control of active and passive RF and multi-intelligence sensor suites in response to changing mission goals and environments. Develop technology to enable affordable upgrades to radio-frequency signal receivers. In addition to SWaP reductions these improvements include increased bandwidth and sensitivity, and responsiveness to a greater range of waveforms.	16.197	7.519	5.403	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2008: Completed initial demonstration of advanced mode control concepts to provide concurrent multi-function radio-frequency sensors and electronic warfare compatibility on a single platform. Developed integrated radio-frequency (sensors and electronic warfare) and electro-optical modeling, simulation, and analysis capabilities to address broader system-level multi-intelligence trades. Developed advanced digital receiver techniques for adaptive electronic support for passive multi-mode platform operations. Continued development and evaluation of advanced digital receiver/exciter technologies for electronic support, electronic protection, electronic attack, and radar applications that support multiple degrees-of-freedom adaptivity. Continued development and evaluation of advanced digital receiver signal processing concepts/techniques for adaptive operation in complex signal environments. Performed digital receiver/exciter simulation, modeling, and analysis for electronic warfare scenarios in modern signal environments. Refined reductions in size, weight, and power in radio-frequency sensors compatible with severely constrained unmanned air platforms. In FY 2009: Demonstrate integration of an electronic warfare and surveillance suite in a size, weight, and power constrained environment. Continue to develop and evaluate advanced mode control concepts to provide concurrent radio-frequency sensors and electronic warfare with electro-optical compatibility on a single platform. Define approaches allowing the simultaneous design and development of sensors and their back-end exploitation functions. Develop advanced electronic support digital receiver concepts/techniques for spatial and temporal adaptivity to overcome limitations to precision emitter parameterization in complex environments. Continue development and evaluation of advanced adaptive digital receiver/exciter technologies for electronic support, electronic protection, electronic attack, and active and passive multi-mode sensor applications. Continue digital receiver simulation, modeling, and analysis for electronic warfare scenarios in modern signal environments. Continue to refine reductions in size, weight, and power in radio-frequency sensors compatible with severely constrained unmanned air platforms. In FY 2010: Continue demonstration of advanced RF receiver hardware and digital receiver/techniques generators technologies. Initiate new effort for the development of an adaptable (cognitive) ES and/or EA capability.				
	0.803	4.751	4.900	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop robust, ultra-wide bandwidth antenna technology for use in operational and future aerospace platform electronic apertures. Develop innovative technologies and architectures for extremely wideband apertures to provide additional multi-level functionality for advanced manned and unmanned platforms. Assess next generation applied radio-frequency aperture technology. Effort completes in FY 2010. In FY 2008: Integrated compact digital receiver/exciter to thin-profile array. In FY 2009: Lab demonstration and testing of thin-profile array with integrated receiver and exciter. In FY 2010: Complete design and development of multi-function thin-profile array with integrated receiver and exciter.					
MAJOR THRUST: Develop multi-function radio-frequency sensing and electronic warfare/information operations concepts and radio-frequency transformational element level arrays for concurrent multi-mode operation. In FY 2008: Developed autonomous constellation of active and passive air, space, and ground sensor techniques for close-in sensing applications using distant sources of opportunity. Designed and developed panel technology for multi-mode array to demonstrate concurrent operation. In FY 2009: Conduct lab demonstration of autonomous constellations of active and passive air, space, and ground sensor techniques for close-in sensing and electronic warfare/information operations applications using distant sources of opportunity. Demonstrate and test multi-mode array with element-level digital beam forming. In FY 2010: Design and develop highly digital electronically scanned array with transmit and receive capabilities for multi-mode radio frequency sensing. Develop integrated receiver/exciter and digital beamforming concepts to support wideband multi-INT sensing systems including modeling and simulation capability, critical components, algorithms, and subsystem architectures.		1.217	2.919	2.796	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop digital radio frequency receiver and exciter technology to support digital beam forming and electronic warfare/information operations applications. This thrust emphasizes advanced, adaptive digital receivers and exciters for cognitive electronic support and electronic attack applications. In FY 2008: Developed subsystem engineering, simulation, and characterization technologies for integrated wideband radio-frequency aperture, wideband receiver and exciter, and digital beam-forming signal processing. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		2.271	0.000	0.000	
MAJOR THRUST: Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, electronic protection, and target identification by exploiting diversity in frequency, delay, polarization, and modulation and coding. Develop multi-platform, multi-mission sensor, and electronic warfare adaptive processing algorithms that improve detection, location, and electronic attack performance. In FY 2008: Evaluated distributed processing technology for next generation deep-reach target detection and tracking. Utilized high fidelity simulation tools. Planned for future experiments. In FY 2009: Initiate and conduct experiments to demonstrate the advantages and performance improvements of adaptive transmit waveforms, new distributed signal processing techniques, and distributed sensing and electronic warfare/information operations for multi-band, multi-platform, multi-mode, and shared aperture applications. In FY 2010: Investigate and evaluate waveform diversity techniques and multiple-input/multiple-output adaptive processing algorithms to improve electronic protection functions in conventional and advanced radio-frequency systems. Continue development of distributed signal processing techniques to obtain high spatial		4.568	7.567	14.698	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
resolution with limited transmit bandwidth, and to detect challenging targets such as those with low radar cross-section.				
MAJOR THRUST: Develop hybrid space-based sensor solutions and reduce associated technology risks. Investigate hardware and software implementation approaches for the needs of responsive space needs and of difficult targets from space. Develop space-qualified precision time, position, and velocity sensors capable of operating in jamming environments while enabling multiple platform sensor-to-warfighter operations. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Investigate optimal means of tightly coupling networked sensing platforms with their reference systems by leveraging onboard sensors observations as feedback to robustly calibrate the distributed, multi-platform reference. Conduct ground-based demonstration of modular payload building blocks compatible with operationally responsive space rapid integration requirements.	0.000	0.000	5.265	
MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays to meet the stringent demands of wide area coverage, target detection, and target tracking in severe clutter and interference environments. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Evaluate advanced surface moving target indication algorithms and computing architectures for high altitude, environmentally constrained radio frequency sensing system applications. Evaluate emissions mapping and bistatic radar techniques for providing space situational awareness.	0.000	0.000	1.732	
MAJOR THRUST: Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. Supports intelligence, surveillance, and reconnaissance capabilities.	0.000	0.000	0.160	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Demonstrate a responsive space payload.					
MAJOR THRUST: Develop sensor techniques to achieve highly accurate and robust navigation performance for hypersonic air vehicles in prompt global strike applications. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Design a radio-frequency hardware-in-the-loop testbed to implement hypersonic air vehicle plasma characteristics, platform trajectories, and highly accurate and robust navigation techniques for space-based applications. Demonstrate a constructive systems engineering model to assess hypersonic navigation techniques in terms of measures of performance and warfighter utility. Note: This effort was initiated in Project 44SP.		0.000	0.000	1.121	
CONGRESSIONAL ADD: Weather Sensors for Cursor On Target. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Weather Sensors for Cursor On Target. In FY 2010: Not Applicable.		0.000	1.596	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Technology.	0.000	0.000							Continuing	Continuing
PE 0603203F/ Advanced Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0603253F/ Advanced Avionics Integration.	0.000	0.000							Continuing	Continuing
PE 0602782A/ Command, Control, Communications Technology.	0.000	0.000							Continuing	Continuing
PE 0602232N/ Navy C3 Technology.	0.000	0.000							Continuing	Continuing
PE 0603792N/ Advanced Technology Transition.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

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